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TOWN BROOK LOCAL PROTECTION

MASSACHUSETTS COASTAL STREAMS

FEASIBILITY REPORT FOR WATER RESOURCES DEVELOPMENT

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APPENDICES

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The report appendices encompass an assessment of economic and social aspects, a formulation of detailed plans, public views and responses, hydrology and hydraulics, geotechnical engineering, engineering design and cost estimates, recreation and natural resources, social and cultural resources, economic studies, and real estate studies.

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Report Appendices

REPORT APPENDICES

APPENDIX A	ECONOMIC AND SOCIAL ASSESSMENT
APPENDIX B	FORMULATION, ASSESSMENT AND EVALUATION OF DETAILED PLANS
APPENDIX C	PUBLIC VIEWS AND RESPONSES
APPENDIX D	HYDROLOGY AND HYDRAULICS
APPENDIX E	GEOTECHNICAL ENGINEERING
APPENDIX F	ENGINEERING DESIGN AND COST ESTIMATES
APPENDIX G	RECREATION AND NATURAL RESOURCES
APPENDIX H	SOCIAL AND CULTURAL RESOURCES
APPENDIX I	ECONOMIC STUDIES
APPENDIX J	REAL ESTATE STUDIES

APPENDIX A

ECONOMIC AND SOCIAL ASSESSMENT

APPENDIX A

Economic and Social Assessment

	Page
Flood Losses	A-1
Extent and Character of Flood Area	A-1
Damage Surveys	A-3
Recurring Losses	A-3
Trends of Development	A-5
Social Assessment	A-6
Introduction	A-6
The Study Area	A-6
Population	A-6
Housing	A-7
Economy	A-8
Land Use	A-10
The Without Project Condition	A-13
Population Projections	A-13
Economic Trends	A-13
Future Growth and Development	A-13
Future Flood Hazard	A-15

LIST OF TABLES

Table No.		
1	Number of Structures Within SPF Flood Plain	A-2
2	Depth Damage Information	A-2
3	Recurring Losses	A-4
4	Total Annual Losses	A-4
5	Population Data	A-6
6	Population by Age Group	A-7
7	Housing in Census Tracts	A-8
8	Employment by Industry	A-9
9	Occupations of Quincy	A-10
10	Land Use, Quincy	A-11

LIST OF FIGURES

Figure 1 Generalized Land Use

Figure 2 Existing Zoning Pattern

Flood Losses

Extent and Character of the Flood Area

The areas of Quincy subject to flooding by Town Brook which would be protected by the proposed project are the Brook Road Pool, the Shopping Center Pool, and the Bigelow Street Pool. An overflow area map has been included in Appendix D showing the flood limits for the reference flood (1968) and for the standard project flood. There are three geographic areas or flood pools discussed in the economics section of this report. The flood pools were established based upon hydrologic data gathered at specific index stations. The Brook Road Pool covers the length of Brook Road and extends to Granite Street on the east. To the west it reaches Intervale Street and Water Street. The Shopping Center Pool is that portion of the central business district bounded by Parkingway Road, School Street, and Hancock Street. The Bigelow Street Pool constitutes the area between Bigelow Street and Elm Street north to Washington Street, including Miller Stile Road.

Three other flood pools suffer losses from flooding by Town Brook: the Braintree Pool, the Centre Street Pool, and the Town River Pool. The Braintree Pool is the area of Lakeside Drive, Howie Street and Walnut Street. The Centre Street Pool includes Centre Street and is bounded by Liberty Street, Penn Street and Columbia Street. The Centre Street Pool includes the Raytheon complex and the new MBTA station currently under construction. The Town River Pool is the last pool before Town Brook empties into the bay.

Three pools are not included in the economic analysis. The Braintree Pool and the Centre Street Pool will be protected from flooding by the work currently under construction by the MDC. The Town River Pool suffers minimal losses from Town Brook flooding, but does experience tidal flooding. The amount of losses will not change from project implementation.

The project area is characterized by low-to-middle income residential neighborhoods, and by areas of industrial and commercial land use. The Brook Road Pool is primarily residential. There are industrial activities bordering upon the Center Street Pool and commercial activities bordering the Shopping Center Pool. Residential structures appear at the Bigelow Street Pool mixed with commercial activities in the area bordering the Shopping Center Pool.

Table 1

Number of Structures within the SPF
Flood Plain by Property Type and Decade*

Area/Property Type	Residential	Commercial	Industrial	Public
Brook Road Pool	135 **	29	7	-
Shopping Center Pool	1	60	-	1
Bigelow Street Pool	69	6	2	2
TOTAL	205	95	9	3

*Quincy is a densely settled urban area. The flood plain is completely developed. No changes in present zoning regulations are anticipated and it is assumed that the future will see replacement of structures with similar activities.

**One apartment building is planned for construction on vacant land in the Brook Road Pool. This is discussed in the Economics Appendix I (pp 15-16).

Table 2

Depth-Damage Information for Sample Structures*

Commerical structure: 2 story building with basement, appraised value of $580,000 not including contents, 17,000 sq. ft.

0	+1	+2	+3	+4	+5	+6
				$68,000	$105,000	$113,000

Commercial structure: 1 story building with basement, appraised value of $76,000 not including contents, 2,000 sq. ft.

0	+1	+2	+3	+4	+5
$5,000	$10,00	$14,000	$15,000	$19,000	$20,000

Residential structure: approx. value $50-70,000, Cape Cod

-1	0	+1	+2	+3
$4,500	$5,000	$5,300	$5,500	$12,500

Residential structure: approx. value $40-60,000, 2 family

-1	0	+1	+2	+3
$3,000	$3,300	$3,600	$5,500	$9,000

*Depth-damage information for sample structures was not used to compute losses for the economic analysis. This information is included to illustrate typical damages for typical structures in the Town Brook flood plain.

Damage Surveys

A detailed damage survey was conducted by damage analysts of the NED in 1970 and a complete on-site update study was performed in the latter part of 1979. The survey consisted of a property-by-property canvas of all structures in the flood plain as defined by the highwater lines and all adjacent properties up to elevations of three feet higher than the reference flood (1968 flood). The damage analysts made their own assessment of potential flood losses and verified them with some of the property owners. Knowledgeable property owners were consulted when available. Further damage studies were conducted in 1980 where needed to include structures within the SPF flood plain but only subject to flooding at depths greater than three feet higher than the reference flood.

The damage survey evaluated physical damages to buildings and contents as well as nonphysical losses, and the emergency costs associated with a flood, including the costs of temporary shelter and subsistence. Estimates were also made for stages below the reference flood level as well as the stage at which damage would begin.

Recurring Losses

The recurring losses are estimated in Table 2 and Table 3 for the 1968 reference flood, the 100 year flood, and the SPF/500 year flood. The recurring losses are broken down by zone and by type of loss. The recurring losses for a flood stage elevation equivalent to the 1968 event would be $2,770,000 (April 1980 price level). The recurring losses for the 100-year event are approximately $13,470,000 and for the SPF recurring losses are estimated to be $24,860.

The recurring losses for the reference flood (1968) are distributed among the three flood pools as follows: Brook Road 14 percent; Shopping Center 23 percent; and Bigelow Street 63 percent. The distribution for the 100 year event is Brook Road Pool 13 percent; Shopping Center Pool 71 percent; and Bigelow Street Pool 16 percent. The distribution of losses for the SPF is Brook Road Pool 37 percent; Shopping Center Pool 48 percent; and Bigelow Street Pool 15 percent.

The recurring losses for the reference flood are distributed by type of loss: commercial 62 percent, industrial 2 percent, residential 35 percent, and public 1 percent. The distribution for the 100 year event is commercial 82 percent; residential 15 percent; and public 1 percent. The distribution for the SPF is commercial 62 percent; industrial 6 percent; residential 31 percent; and public 1 percent.

The 12' tunnel eliminates 99 percent of the recurring losses for the reference flood, 90 percent of the recurring losses for the 100 year event, and 45 percent of the recurring losses for the SPF.

Table 3

Recurring Losses by Zone and Property Type*
($1,000)

	Residential	Commercial	Industrial	Public	Total
Brook Road Pool					
Reference Flood	330	23	42	-	395
100-Year Flood	1,121	294	256	-	1,671
Standard Project Flood	5,820	1,993	1,429	-	9,242
Shopping Center Pool					
Reference Flood	2	633	-	-	635
100-Year Flood	5	9,615	-	-	9,620
Standard Project Flood	5	11,955	-	-	11,960
Bigelow Street Pool					
Reference Flood	629	1,066	5	40	1,740
100-Year Flood	957	1,153	10	54	2,174
Standard Project Flood	1,999	1,441	137	80	3,657
Total					
Reference Flood	961	1,722	47	40	2,770
100-Year Flood	2,083	11,062	266	54	13,465 (13,470) approx.
Standard project Flood	7,824	15,389	1,566	80	24,859 (24,860) approx.

Annual Losses

The total annual losses are $2,062,000, the distribution by zone is Brook Road Pool 11 percent; Shopping Center Pool 78 percent; and Bigelow Street Pool 11 percent.

The 12' tunnel eliminates 96 percent of the annual loss and the 8' tunnel eliminates 77 percent of the annual losses.

Table 4

Total Annual Losses Under the Without Condition

Brook Road Pool	227,000
Shopping Center Pool	1,616,000
Bigelow Street Pool	219,000
Total	2,062,000

*Losses by decade are not shown. No significant change in future losses is expected.

Trends of Development

Development in the Town Brook flood plain is discussed in more detail under the future "without" condition. The flood plain is developed nearly to potential at the present time. Two maps are included on Plates A1 and A2 showing generalized land use and the existing zoning pattern. The land use patterns are expected to remain substantially unchanged in the future. There is one 4-acre lot of vacant land in the flood plain. Any new activities that would locate in the flood plain would most likely replace existing activities of the same kind. Major urban renewal is considered likely, concentrating upon the downtown area. This is discussed in the Economic Appendix I under future benefits.

SOCIAL ASSESSMENT

I. Introduction

The purpose of this report is to identify and assess the social and economic impacts associated with a local protection project at Town Brook in Quincy, Massachusetts. The feasibility study report includes four socio-economic elements: a description of the base or existing condition, a projection and description of the without-project condition, an assessment of a full array of alternatives, and an accounting of the contributions of the detailed plans to social well-being.

The study area has generally been defined as the city of Quincy, so most data presented are city-wide. Where possible, data more specific to the areas immediately surrounding Town Brook have been provided. Although Old Quincy Reservoir, which is part of the selected plan, is located in Braintree, Braintree was not expected to be significantly affected and was not considered part of the study area. Nonetheless, a section describing the area immediately surrounding the reservoir has been included and impacts there have been assessed.

II. The Study Area

A. Population

The U.S. Census recorded the 1975 population of Quincy as 91,494. Quincy has shown continuous growth since 1920. The largest periods of growth were between 1920 and 1930, when the population increased 50.4 percent, and 1949 and 1950 when a 10.6-percent increase occurred. Data are not yet available for 1980, but the first 5 years of the past decade have increased by 4 percent. Since 1950, growth within Quincy has been slower than the growth experienced within the Boston Standard Metropolitan Statistical Area (SMSA) and the State of Massachusetts. This information is displayed in Table 5.

TABLE 5

POPULATION DATA

	#	Quincy % Change from preceding decade	Boston SMSA #	Boston SMSA % chg.	Massachusetts #	Massachusetts % chg
1975	91,494	4.0	2,890,368	-0.3	5,812,489	2.2
1970	87,966	0.6	2,899,101	7.9	5,689,170	10.5
1960	87,409	4.3	2,688,083	8.6	5,148,578	9.8
1950	83,835	10.6	2,476,191	9.3	4,690,514	8.7
1940	75,810	5.3	2,264,759	2.0	4,316,721	1.8
1930	71,983	50.4	2,219,629	15.9	4,249,614	10.3
1920	47,876		1,914,642		3,852,356	

The Census Bureau has divided the city of Quincy into twelve census tracts for which it has compiled demographic data. Four tracts, 4177, 4179, 4180, and 4181, approximate the project area and had a 1970 population as follows:

4177	7,324
4179	8,452
4180	10,928
4181	6,726

These tracts total 33,490, or 38.1 percent of Quincy's total population. By age group, these four tracts have a greater proportion of their population in the 65 and over group than in the city as a whole, and a smaller proportion under the age of 20. Population by age group for the four tracts and city are presented in Table 6.

TABLE 6

POPULATION BY AGE GROUP

	Tracts 4177, 4179 4180, 4181		Quincy	
Group	#	%	#	%
Under 5	2,615	7.8	7,125	8.1
5-9	2,453	7.3	7,371	8.4
10-14	2,539	7.6	7,830	8.9
15-19	2,519	7.5	7,389	9.4
20-24	2,947	8.8	7,523	8.6
25-34	3,919	11.7	9,856	11.2
35-44	3,080	9.2	8,679	9.9
45-54	4,143	12.3	10,610	12.1
55-64	3,996	11.9	9,618	10.9
65 and over	5,362	16.0	11,965	13.6
Total	33,573	100.1	87,966	100.1

Source: 1970 U.S. Census

B. Housing

Residential use accounts for the largest proportion of developed land. In 1970, Quincy had a total of 29,050 year-round housing units. Close to 50 percent of the structures were one-family dwelling units, 23 percent were two-family homes, and the remainder were multi-family structures. More than 50 percent were owner-occupied.

About 40 percent (11,904) of the city's year-round housing units are located within the four census tracts that approximate the study area. More than 50 percent of these (51.6) are renter occupied, 46.2 percent are owner

occupied, and the remainder are vacant. Of these structures within the study area 35.5 percent are one-family units. At the other extreme, 5.6 percent have 50 or more dwelling units. Table 7 presents the total breakdown of units per structure.

Table 7

Housing in Census Tracts

4177, 4179, 4180, 4181, in Quincy

Units in Structure	# Structures	% of Total
1	4,221	35.5
2	3,444	28.9
3 and 4	2,176	18.3
5 to 49	1,393	11.7
50 or more	670	5.6
TOTAL	11,904	100.0

Source: 1970 U.S. Census

C. Economy

1. Industry

Historically, Quincy has been a manufacturing community and most of the major employers in the city are still manufacturing companies. The largest single employer is General Dynamics, one of the Nation's most important shipbuilding facilities. Raytheon and North American Rockwell's Boston Gear Works also account for sizable numbers employed in the manufacturing sector. Although manufacturing still has a predominant role in the economy, its importance has lessened.

Data gathered by the State Division of Employment Security can provide some perspective of the Quincy economy by comparing Quincy industry by employment statistics for 1967 and 1977.

Table 8
Employment by Industry
Quincy, 1970

Sectors	1967	% of total	1977	% of total	% chg. 1967-1977
Agric., Forestry Fisheries	22	0.1	9	0.1	-59.1
Mining	8	0.1	20	0.1	150.0
Construction	1,692	5.0	1,268	4.5	-25.1
Manufacturing	16,641	48.8	9,223	32.6	-44.6
Trans., Comm., Utilities	1,632	4.8	1,020	3.6	-37.2
Wholesale/Retail Trade	10,318	30.3	8,260	29.2	-19.9
Finance, Insurance, Real Estate	1,331	3.9	3,555	12.6	167.1
Services	2,434	7.1	4,911	17.4	101.8
TOTAL	34,077	100.0	28,266	100.0	-17.1

Source: Massachusetts Division of Employment Security

Along with the declining employment in the manufacturing sector, substantial decline also occurred in the construction, wholesale/retail trade, and transportation/communication/utilities sectors. Although wholesale/-retail trade showed a 20 percent decrease in employment over this period, it still maintained almost a 30 percent contribution of number employed, following manufacturing as the second largest employing sector in Quincy. The wholesaling portion of this sector is stabilized by Quincy's role as a distribution center for the South Shore.

Significant increases in employment were noticed in the finance/insurance/real estate and services sectors. However, these gains were not great enough to offset an overall decline in employment of 17 percent between 1967 and 1977. The increases in employment in the finance/insurance/real estate and services sectors resulted from two large development, State Street South and the Kemper Insurance complexes.

2. Labor Force

Quincy's total labor force averaged 43,605 persons in 1979. This ranged from a low of 42,275 in November to a high of 44,296 in January. The unemployment rate averaged 5.5 percent in Quincy in 1979. This compares to an average unemployment rate of 5.2 for the Boston SMSA and 5.6 for the State of Massachusetts.

The 1970 Census, although categorizing a smaller labor force than that of 1979, does provide a general idea of some of the major occupations in the Quincy work force. The largest occupational grouping represented in the 1970

statistics, clerical and kindred, composed 25 percent of the labor force. This group was followed by craftsmen, foremen, and kindred with 15.8 percent professional, technical, and kindred with 15.5 percent and service workers with 12.0 percent. The remaining occupational categories are listed in Table 9.

Table 9
Occupations of Quincy Residents, 1970

Occupations	#	% of total
Prof., Tech., & Kindred	5,754	15.5
Managers & Administrators	2,893	7.8
Sales Workers	3,139	8.4
Clerical and Kindred	9,290	25.0
Craftsmen, Foremen and Kindred	5,868	15.8
Operatives	4,386	11.8
Laborers	1,252	3.4
Farmers and farm managers	50	0.1
Service workers	4,472	12.0
Private household workers	94	0.3
TOTAL:	37,198	100.1

Source: U.S. Census

As indicated above, most of Quincy's labor force holds blue collar positions. A report entitled "Job Opportunities in Quincy" describes Quincy as "the classic middle-class working community." This report also indicates that about half the residents work outside Norfolk County and about two-thirds of these work in Boston.

Land Use

1. General Characteristics

Land use data generated in 1971 for the McConnell remote sensing studies indicated that residential uses represented the largest category in Quincy, accounting for 35.1 percent of Quincy's land area. McConnell also had collected data in 1951, permitting comparison land use changes for the 20-year period. This information is given in Table 10.

Table 10
Land Use, Quincy

Uses	1971	%	1951	%	% Chg.
Residential	3,769	35.1	4,019	37.4	-6.2
Commercial	467	4.3	311	2.9	50.2
Industrial	500	4.6	217	2.0	130.4
Transportation	318	3.0	248	2.3	28.2
Open & Public	430	4.0	198	1.9	117.2
Forest	3,586	33.4	4,129	38.4	-13.2
Agriculture/Open	372	3.5	629	5.9	-40.9
Wetland	806	7.5	1,001	9.3	-19.5
Mining/Waste Disposal	256	2.4	--	--	--
Outdoor Recreation	248	2.3	--	--	--
TOTAL	10,752	100.1	10,752	100.0	0.0

Source: William P. McConnell, Remote Sensing: 20 years of Change in Norfolk County, Massachusetts, Massachusetts Agricultural Experiment Station Research Bulletin, Amherst, Mass.

Four land use categories lost acreage over the 20-year period. Agriculture/open decreased by 40.9 percent wetlands by 19.5 percent, forest by 13.2 percent, and residential by 6.2 percent. Those uses showing the greatest increases were industrial with 130.4 percent additional acreage and public/open with a 117.2 percent increase. By 1971, commercial acreage had increased by one-half of the 1951 acreage, reaching a total of 467 acres.

As indicated above, residential use predominates the developed acreage in Quincy. Because almost a third of Quincy is in the Blue Hills Reservation in the southwestern portion of the city, residential development is concentrated in the north and northeast sections. Industrial and commercial uses appear to be scattered within these residential areas. The greatest concentrations of industrial development have occurred around Town River Bay and along the Penn Central Railroad tracks. A large area bordering the Blue Hill Reservation is devoted to quarrying activities. The most significant commercial development is Quincy Center in the area of Granite, Hancock and Washington Streets. Other commercial uses are scattered along major roadways, including the Southern Artery and Quincy Avenue.

2. Flood Prone Areas

During floods, water is stored in six "pools" that form along Town Brook from the Old Quincy Reservoir to Town River Bay. These pools have been identified in the report. Four of these pools are within the project area being considered by the Corps. They are Brook Road Pool, Shopping Center Pool, Bigelow Pool and Town River Pool.

Brook Road Pool

The Brook Road Pool covers almost the entire length of Brook Road. To the east of Brook Road the pool reaches the backyards of properties fronting Granite Street. On the west the pool encompasses Intervale Street (from its junction at Brooks Avenue and Brook Road) and includes areas north and south of Water Street. Approximately 110 structures lie within the Brook Road Pool, some 90 percent of which are homes. These homes are a mixture of one and two-family dwellings, with a handful of buildings having six or more units per structure. The remaining structures are commercial and industrial estalishments such as a sheet metal company, a rubber company, an auto repair service, monument sales, and a variety store. Also within this flood pool are some playing fields.

Shopping Center Pool

The Shopping Center Pool encompasses the triangle bounded by Parking Way, School Street and Hancock Street within the central business district. During severe flooding, water is likely to reach the opposite side of Hancock Street as well. Because the brook runs underground for much of its length, particularly within this area, there is limited surface flooding. Generally this flooding is restricted to parking areas, sidewalks and streets. The flooding experienced by the stores, shops and buildings there is due to backwater from Town Brook, and backup of foundation drains and is confined to basements. The structures, predominantly commercial establishments, number close to 60 and make up the main downtown shopping section in Quincy. The MBTA station is also prone to flooding problems.

Bigelow Street Pool

The Bigelow Street Pool generally extends from the junction of Bigelow and Elm Streets and lies between these two streets as each runs northerly to Washington Street. Most of Miller Stile Road is also inundated. Under severe flooding, about 50 properties on both sides of Bigelow, extending through to Revere Street, are damaged. These are mostly one and two-family dwellings and a few commercial establishments which lie on the fringe of the downtown area.

Town River Pool

Town River Pool is the last pool along Town Brook before it empties into Town River Bay. The flood prone area has no structural development, but severe floods may reach some homes along the fringe of the pool. Basically, this flood pool consists of wetlands and a playing field.

3. The Quincy Reservoir Area

The Old Quincy Reservoir is located within a residential area in Braintree, about a half mile from the Quincy border. When the capacity of the reservoir and the spillway is exceeded, the water seeks an outlet along Lakeside Drive and flows to the Howie and Walnut Streets neighborhood. Some ponding

occurs that threatens the Lakeside School on Lakeside Street and homes in the area. These residences are one-family dwelling units on quarter-acre lots.

III. The Without Project Condition

A. Population Projections

Population projections prepared by the Office of State Planning indicate that Quincy will continue to grow, reaching a population of 95,500 by 1990 and remaining at that level through the year 2000. This is a 4.4 percent increase over Quincy's 1975 population. Projections beyond 2000 were not available. Increases in population are expected to result from a continued migration of people from Boston, more specifically South Boston and Dorchester, who desire a more suburban area with good accessibility into Boston. It is expected that new housing to accommodate an increased population would take the form of multifamily units. Most likely these would be located near MBTA stations for easy commuting into Boston.

B. Economic Trends

Available employment projections for Quincy indicate that employment in 1985 could total anywhere from 36,200 to 38,200. The Metropolitan Area Planning Council has prepared projections through the year 2000, which indicate that Quincy's employment could reach 39,000 by that time. Of this number, 9,000 would be employed in the manufacturing sector.

The most recent trends experienced within the industrial sectors are expected to continue. Overall employment in the manufacturing sector would continue to be controlled by General Dynamics and the other large companies; and employment in the services sector would increase, especially in business, legal, health, and social services. More opportunities are also anticipated in the finance/industrial/real estate and the wholesale/retail trade sector. Basically, then, Quincy is expected to experience an overall decline of an economy dominated by manufacturing and the growth of suburban-type services and office-related activities.

C. Future Growth and Development

Quincy's "Local Growth Policy Statement" prepared for the Office of State Planning, provides some general indications of the direction Quincy most likely will take in terms of future development and also what direction its residents would like to see the city take.

A few overriding goals that seem to be reflected in most of Quincy's policies are a continuation of current "controlled growth" in land use development, expansion of the city's overall economic base, and preservation of neighborhood identity and quality housing stock.

Basically, the city has been moving in a positive direction. While many of the country's older city centers have lost their viability and self-subsistence, Quincy has been able to maintain a stable base. Several activities are

underway, some in planning and some already under construction, to promote the viability of Quincy. Development activities currently are directed toward the revitalization and rehabilitation of the central business district as well as the smaller commercial districts scattered throughout the city.

The largest development project being considered is a large retailing/-office/hotel complex which would be built in the central business district. To allow better access to the area, Revere Road would be extended in a north-westerly direction by the proposed Crosstown Connector.

The retailing portion of the mall would include two anchor tenants. A number of small shops, restaurants and cinemas are expected to lease the remaining space. The proposed hotel wold be located on the Parking Way. Plans indicate a 200-room hotel with banquet and function room facilities, a restaurant and lounge. Some office space may also be provided within the retailing portion of the complex with direct access from Hancock Street.

Improved transportation routes are an essential element to the success of the downtown revitalization. A Crosstown Connector, as mentioned earlier, is proposed for construction. It would extend southeasterly from Granite Street behind the mall complex joining Revere Road. Another proposed route that would provide better access into and through the downtown is the Upland Road Extension. It would provide access from Routes 3 and 128 through the downtown area to Upland Road.

Quincy takes an active role in securing Community Development Block Grants (CDBG) from the U.S. Department of Housing nd Urban Development. The city is now in its sixth year of participation in the CDBG program and its efforts to revitalize commercial areas and rehabilitate deteriorating housing. Portions of three strategic areas sited in the city's latest grant proposal for funds between 1 July 1980 and 30 June 1981 are part of the Town Brook project area; the Southwest Neighborhood Strategy Area, the South Quincy Neighborhood Strategy Area, and the Commercial Zone Revitalization area.

The Commercial Zone Revitalization Area Project encompasses the central business district and is aimed at revitalizing the deteriorated and blighted conditions within the CBD. It would be implemented with the other projects, currently underway, as described above. The project specifically is seeking funding assistance to complete the preparation of engineering design plans and construction bid documents for the proposed extension of Upland Road. Funding assistance for the CBD Shorefront Rehabilitation Grant Program for these individuals who undertake rehabilitation work of the commercial properties is also being sought under this project.

The Southwest Neighborhood Strategy Area Project involves improvements to the neighborhood's housing stock and public services. More specifically, there are home rehabilitation grants, loans, and physical assistance. The public services funding assistance is requested for operational expenses of the Elderly Outreach Program and the Mental Health Outreach Program. Along with home rehabilitation grants and loans, the South Quincy Neighborhood Strategy Area Project involves funds for public works

improvements, surfacing of streets, construction and reconstruction of sidewalks, and tree planting. Funds for the rehabilitation of the Bradford Street Playground are also requested.

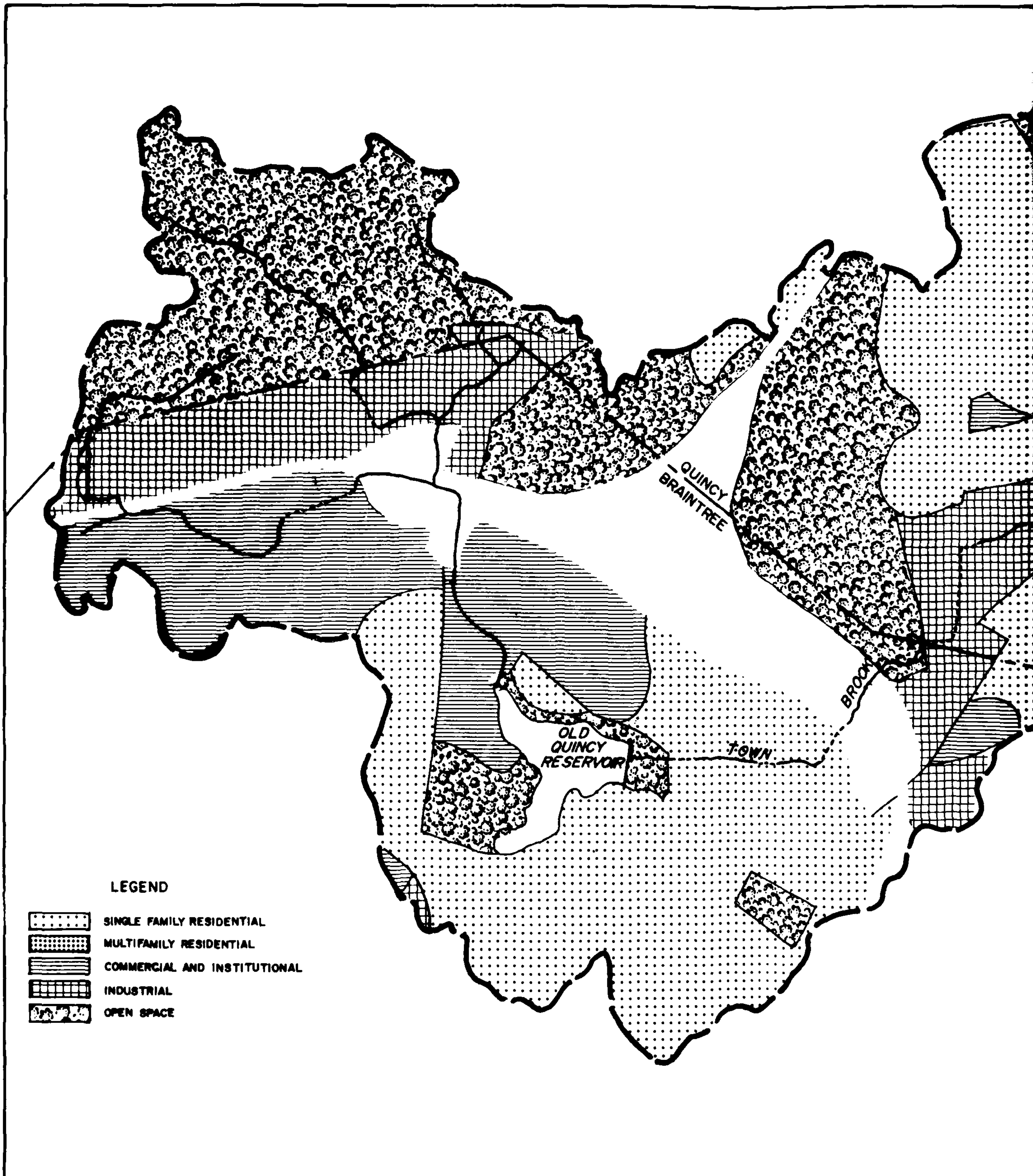
A number of CDBG funded planning activities are scheduled within the study area. It is expected that both the program and Quincy's participation will continue.

D. Future Flood Hazard

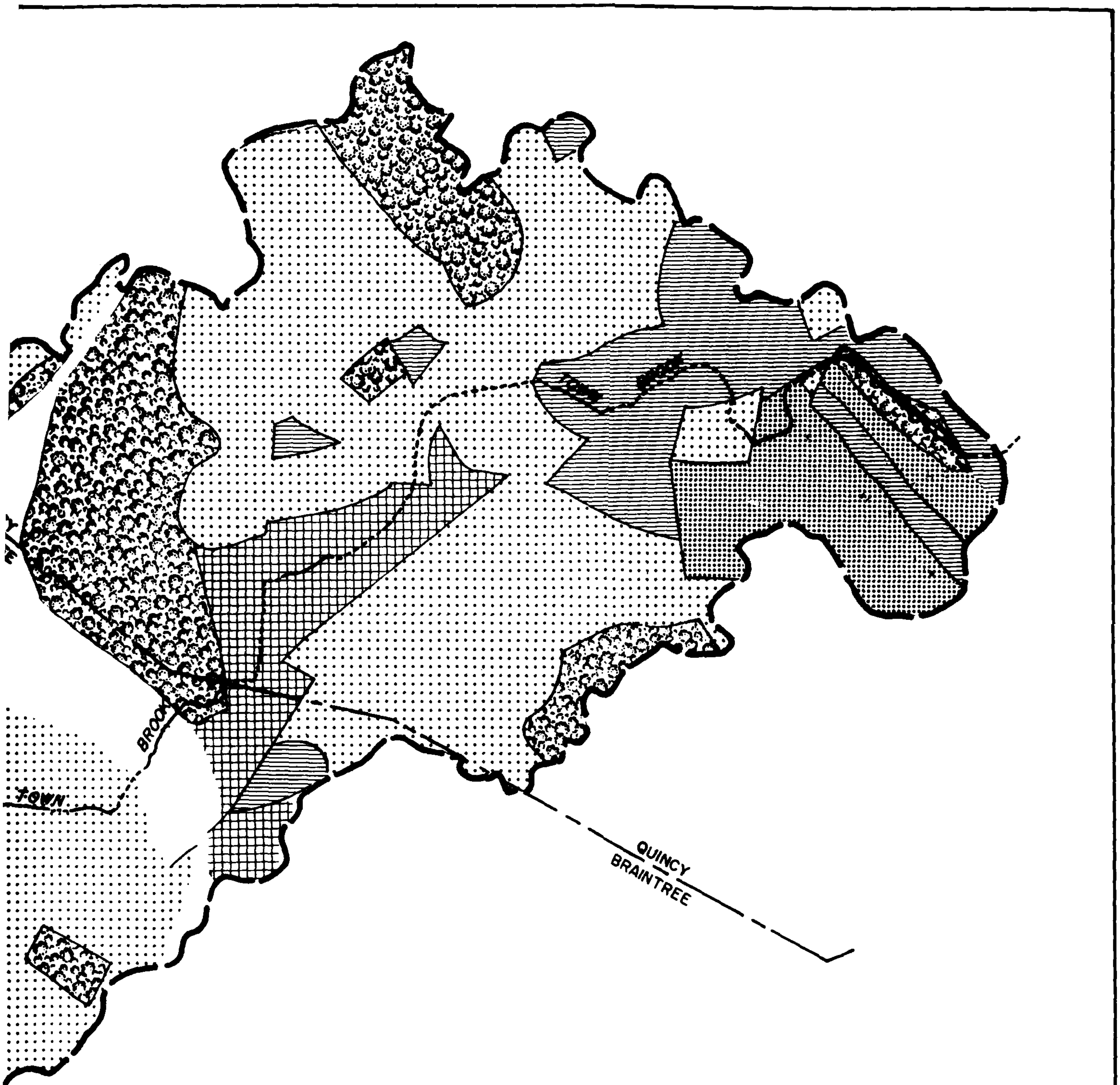
New development in the flood plain would increase runoff rates and flooding in the Town Brook watershed. The new transportation facilities being planned and constructed in the watershed would have a significant impact on the area. These include the new MBTA station and parking garage, a new highway interchange to Routes 3 and 128, and new connector roads to downtown Quincy. As part of the new transportation facilities, drainage improvements are planned to remove local inflows and excess floodflows coming down Town Brook. These drainage improvements have the capability of reducing some flooding in the watershed, however, the improvements being considered move some of the upstream flood pools to a larger flood pool downstream without an adequate outlet to the bay.

Average annual flood damages of $2.1 million would continue to result from the flooding of Town Brook. Extensive damages would still occur in the Brook Road, Shopping Center, and Bigelow Street pools. Increased flooding in the Town River pool would damage residential structures, but not as extensively as the other three pools.

Continued flooding on downtown Quincy would result not only in structural and property damages to homes and businesses but also in lost wages to local employees and lost business to establishments forced to close down. Social costs are incurred when consumers cannot obtain services and goods and transportation problems inconvenience commuters. Future floods would continue to hamper support services in their response emergencies and would require repair of roads and damaged utilities after the flooding has subsided.



QUINCY
BRAINTREE
OLD QUINCY RESERVOIR
TOWN
BROOK
LEGEND
SINGLE FAMILY RESIDENTIAL
MULTIFAMILY RESIDENTIAL
COMMERCIAL AND INSTITUTIONAL
INDUSTRIAL
OPEN SPACE



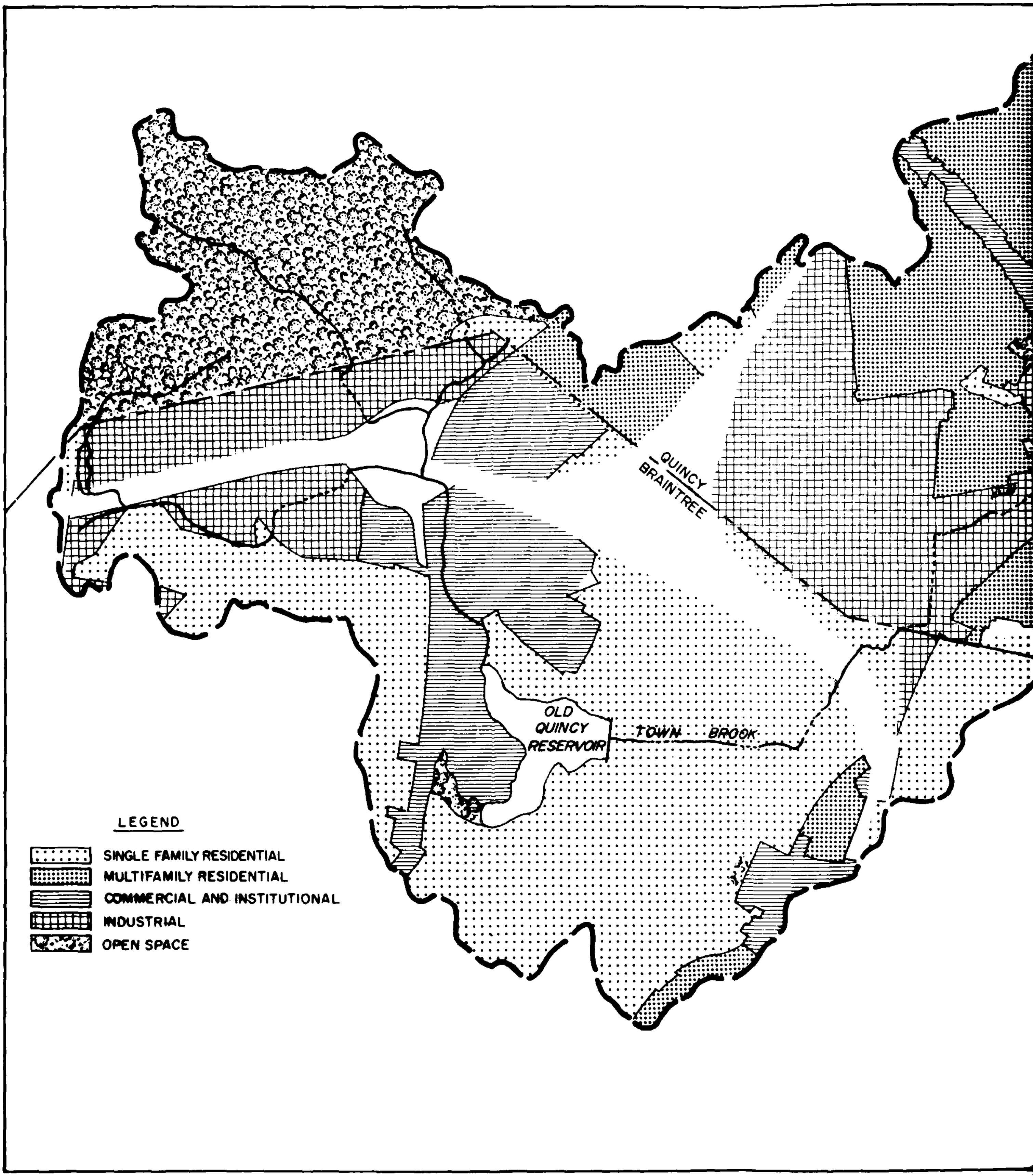
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

GENERALIZED LAND USE

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPT . 30

FIGURE A-1

2


QUINCY
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SINGLE FAMILY RESIDENTIAL
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INDUSTRIAL
OPEN SPACE

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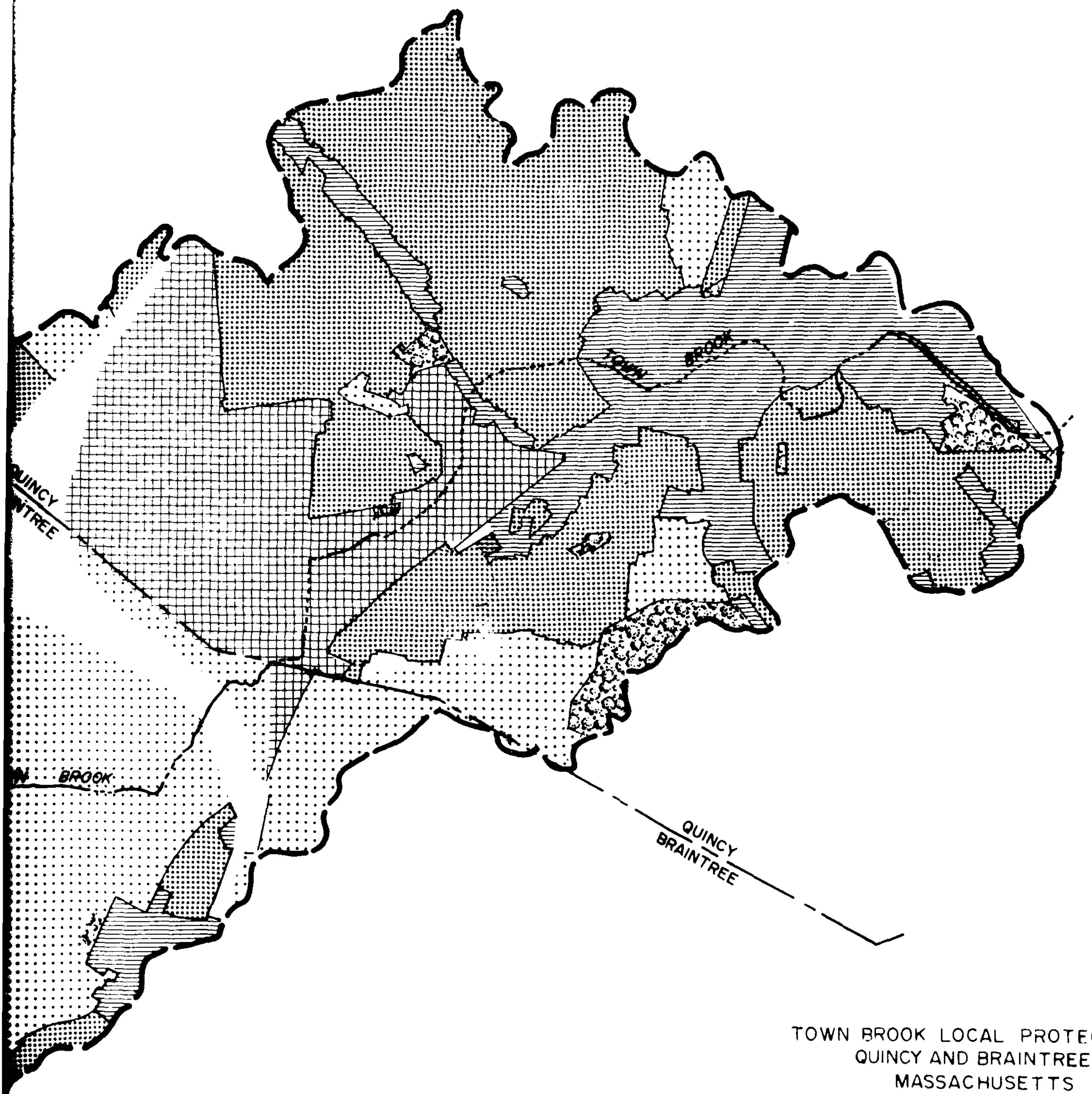

TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

EXISTING ZONING AND OPEN SPACE

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPT 1980

FIGURE A-2

2

APPENDIX B

PLAN FORMULATION AND EVALUATION

APPENDIX B

PLAN FORMULATION AND EVALUATION

TABLE OF CONTENTS

	Page No.
SYSTEM OF ACCOUNTS	B-1
EVALUATION OF ALTERNATIVE TUNNEL OUTLETS	B-3
Description of Outlets	B-3
Preliminary Screening	B-6
Comparison of Tunnel Outlets	B-6
Selected Tunnel Outlet for Detailed Evaluation	B-7
SOCIAL AND ECONOMIC CONSIDERATIONS	B-8
STRUCTURAL ALTERNATIVES	B-8
Impoundment of Floodwaters	B-8
Improvement of Channel Capacity	B-9
Bypass Tunnel	B-9
NONSTRUCTURAL ALTERNATIVES	B-10
Flood Proofing	B-11
Flood Forecasting, Warning and Evacuation	B-11
Flood Insurance	B-11

TABLES

Table No.		Page No
B-1	SYSTEM OF ACCOUNTS	
B-2	SUMMARY COMPARISON OF PRELIMINARY PLANS	
B-3	PRELIMINARY ANALYSIS OF ALTERNATIVE TUNNEL OUTLETS	B-5
B-4	EVALUATION OF ALTERNATIVE TUNNEL ALIGNMENTS	B-6

SYSTEM OF ACCOUNTS

The system of accounts is a display requirement of the Principles and Standards and is used as an integral part of the planning process.

The final system of accounts is shown in Table B-1 and displays the contributions of detailed plans to the accounts of National Economic Development (NED), Environmental Quality (EQ), Social Well-Being (SWB) and Regional Development (RD).

The impacts of the plans are also evaluated in terms of timing, undertainty, exclusivity and actuality. They are displayed in the table as footnotess, which are listed below.

a. Timing

Code	
"1"	Impact expected to occur prior to or during plan implementation.
"2"	Impact estimated to occur within 15 years following plan implementation.
"3"	Impact estimated to occur 15 years following plan implementation.
"+"	Impact occurs at indicated time period and continues for an indefinite future period.

b. Uncertainty

Code	
"4"	The uncertainty associated with an impact is greater than 50%.
"5"	The uncertainty is between 10% and 50%.
6"	The uncertainty is between 0% and 10%.

c. Exclusivity

Code	
"7"	Overlapping entry; fully monetized in NED account

"8"	Overlapping entry; not fully monetized in NED account.

d. Actuality

Code

"9"	Impact will occur with implementation.
"10"	Impact will occur only when specific additional actions are carried out during implementation.
"11"	Impact will occur because necessary additional actions are lacking.

An initial system of accounts, Summary Comparison of Preliminary Plans shown in table B-2 was developed to display information developed in early planning stages. This table compares plans and measures based on preliminary evaluation factors and data.

TABLE B-1
SYSTEM OF ACCOUNTS

Accounts and Effects	Impact Code	PLAN A - Tunnel and Old Quincy Reservoir Improvements: Location of Impacts: Planning Area	PLAN A: Remainder of Nation	PLAN B - Nonstructural Plan - Flood Proofing and and Flood Warning and Evacuation: Location of Impacts: Planning Area	PLAN B: Remainder of Nation
1. National Economic Development (NED)					
Total Flood Damages	1	2,062,000	0	2,062,000	
Benefits					
Flood Damage Reduction	2+	1,970,000	0	399,000	
Future Flood Proofing Costs Saved	2+	2,000	0	-	
Affluence Benefit	2+	24,000	0		
Total Benefits	2+	1,996,000	0	399,000	
Total Future Residual Damages	2+	92,000	0	1,663,000	
Average Annual Cost	1	1,486,000	0	278,000	
Benefit to Cost Ratio		1.34:1	0	1.43:1	
Net Remaining Benefits		510,000	0	121,000	
2. Environmental Quality (EQ)					
Environmental Quality Enhanced					
Water Quality	2,5,10	Eliminate ponding and stagnation of water after flooding		No impact	
Salt Marsh	2,6,9	Flowage easements will preserve marsh		No impact	
Wildlife	2,6,9	Preservation of marsh will protect habitat for wetland species in an urban environment		No impact	
Visual	2,5,10	Eliminated flooding will enhance visual appearance of urban area		No impact	
Fishery	2,5,10	Stabilized reservoir level will enhance appearance and fishery of Old Quincy Reservoir		No impact	
Historical	2,6,9	Document for history a record of the lock and dam on Town Brook Canal		No impact	
Environmental Quality Degraded					
Air Quality	1,6,9	Degraded during construction in vicinity of work areas		Minor impact during construction of flood proofing walls	
Water Quality	1,6,9	Increase in sediment during construction		No impact	
	2,4,9	Addressed by water quality measures			
Fishery (smelt)	2,4,9	No impact		No impact	
Historical	1,6,9	Excavate part of remains of Town Brook Canal lock and dam		No impact	
Salt Marsh	1,6,9	0.25 acre of land adjacent to marsh will be excavated to install connector channel		No impact	

Acco[illegible]ts and E[illegible]s	Impact Code	Planning Area	Remainder of Nation	Planning Area	Remai[illegible] of Nation
3. Social Well-Being (SWB)					
Beneficial Impacts					
Health and Safety	2,6,10	Reduced health and safety risks from flooding to 130 residences		Improved through excavation of 130 residences	
Community Cohesion	2,5,10	Improved to 130 residences as flood protection is provided		No impact	
Desirable Community Growth	2,5,10	Invites community improvement		No impact	
Aesthetic Values	2,5,10	Eliminates flooding will enhance visual appearance of urban areas		Flood proofing walls will be visible	
Historical Resources	2,6,9	Documentation of lock and dam on former Town Brook Canal		No impact	
Transporation	2,5,9	Will not be disrupted during flooding			
Recreational Opportunities	2,5,10	Preservation of marsh and stabilization of reservoir will enhance passive recreation opportunities		No impact	
Educational Opportunities	2,6,9	Flood problems eliminated at Lakeside School		No impact	
Adverse Impacts					
Noise	1,6,9	Temporary increase at construction site		Temporary increase in business and residential areas during construction	
Displacement of Business/People	1,4,9	Construction activities in supermarket parking lot		Temporary evacuation of 130 residences and 60 businesses	
Aesthetics	1,5,9	Construction activities will be visible in urban areas		Construction activities will be visible in urban areas	
Transportation	1,6,9	Traffic disrupted on Southern Artery for 6 months. Construction traffic on Southern Artery, Pond St. and School St.		No impact	
Recreation	1,6,9	Loss of use of ballfield at Monroe Playground during construction		No impact	
Health and Safety	1,6,9	Increase construction traffic creates hazard		False sense of security could isolate people if not evacuated	
4. Regional Development (RD)					
Beneficial Impacts					
Tax revenue	2,5,10	Increased property value, business activity and tax revenue in flood protected areas		No impact	
Desirable Regional Growth	2,5,10	Reduced flooding enhances revitalization of downtown business district.		No impact	
Employment	1,6,9	Provides employment to construction sector for 2 years		Provide employment to install flood proofing measures	
Municipal Finances	2,6,9	Reduced expenditures for flood emergencies		No impact	
Public Facilities and Services	2,6,9	Flood protection for transportation services		No impact	
Adverse Impacts					
Tax Revenue	1,6,9 1,4,9	5 acres of land removed from tax roll		No impact	
Project Cost	1,6,9	Local share of project is $5,188,000		Local project share is $657,000	
Displacement of Business	1,4,9	Supermarket business may be disrupted during construction for a 6 month period		No impact	

Table B-1

TABLE B-2

Summary Comparison of Preliminary Plans - Stage 2

Basic Plans

Accounts	Relief Conduit & Town River Channel & Southern Artery Culverts	Relief Tunnel (8') & Southern Artery Culverts	Relief Tunnel (12') & Southern Artery Culverts	Relief Tunnel (15') & Town River Channel & Southern Artery Culverts	Nonstructural (Flood Proofing)	Ol
1. National Economic Development (NED)						
Flood Control Benefits (ann.)	1,766,000	1,424,000	1,766,000	1,798,000	N/A	
Annual Costs Construction	1,432,000	851,000	1,134,000	1,508,000	167,000	
O&M	12,000	10,000	10,000	12,000	20,000	
Total Annual	1,444,000	861,000	1,144,000	1,520,000	187,000	
Net NED Benefits	322,000	563,000	622,000	278,000		
Benefit to Cost Ratio (BCR)	1.22:1	1.67:1	1.54:1	1.18:1		
2. Environmental Quality (EQ)						
a. Manmade Resources						
Parks and Recreation	No Change	Temporary loss of use on one ballfield	Same	Same	No change	St of be rec
Urban Areas Visual	Eliminating flooding will enhance visual appearance	Same	Same	Same	Flood proofing measures will be visible	New fea to
b. Natural Resources Air Quality	No major change Temporary decrease at construction sites	Same	Same	Same	Same	Sa
Water Quality	Temporary increase in sediment during construction	Same	Same	Same	Same	Sa
		Potential low dissolves oxygen, gas buildup and related reduction of WQ in tunnel	Same	Same		
Fish and Wildlife Smelt Spawning Areas *Smelt Population*	No impact *Discharge from conduit could attract smelt away from natural spawning area*	No impact *Potential negative impact from poor water quality*	No impact Same	No impact Same	No impact *No impact*	No No
Wildlife	Loss of wetland habitat	No impact	No impact	Loss of wetland habitat	No impact	No
3. Social Well-Being (SWB)						
Noise	Temporary increase during construction	Same	Same	Same	Same	No
Displacement of People	Displace two businesses	None	None	None	Temporary relocation during flood events	Pre tem rel flo
Aesthetic Values See Visual EQ account						
Historic Structures Town Brook Canal Lock & Dams	Will disturb remains of lock and dam	Same	Same	Same	No impact	No
Recreation Opportunities	No impact	Temporary loss of use of ballfield at Pond Street			No impact	Sta res pas
Community Cohesion	Improved as flood protection is provided	Same	Same	Same	Promote cooperation during flooding	Eli of res
Desirable Community Growth	Flood protection complements revitalization plans	Same	Same	Same	No impact	No
Transportation	Downtown business district blocked off construction traffic on School St., Pond St., Southern Artery	Construction traffic on School St., Pond St., Southern Artery	Same	Same	Streets closed during flooding MBTA affected	Tra rup Lak
	Traffic delay on Southern Artery	Same	Same	Same		
Health & Safety	Reduced flooding and improved drainage	Same	Same	Same	Evacuation of residents during flood events	Imp dam

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TABLE B-2

Summary Comparison of Preliminary Plans - Stage 2

Basic Plans			Other Measures				
Relief Tunnel (8') & Southern Artery Culverts	Relief Tunnel (12') & Southern Artery Culverts	Relief Tunnel (15') & Town River Channel & Southern Artery Culverts	Nonstructural (Flood Proofing)	Old Quincy Reservoir Improvements	Flooding Easements On Salt Marsh	A&H Documentation of Canal Remains	Without Project Condition
1,424,000	1,766,000	1,798,000	N/A				
851,000	1,134,000	1,508,000	167,000	69,000	1,800	up to 1% of *construction cost*	
10,000	10,000	12,000	20,000	5,000	200		
861,000	1,144,000	1,520,000	187,000	74,000	2,000		
563,000	622,000	278,000		-74,000	-200		
1.67:1	1.54:1	1.18:1					
Temporary loss of use on one ballfield	Same	Same	*No change*	Stabilized level of reservoir will benefits passive recreation	Will preserve marsh for passive recreation	Small landmark could be established	Loss of resource through natural degradation
Same	Same	Same	Flood proofing measures will be visible	New reservoir features added to landscape	Open space will be preserved	No change	No change from existing
Same	Same	Same	Same	Same	No change	No change	No change
Same	Same	Same	Same	Same	No change	No change	No change
Potential low dissolves oxygen, gas buildup and related reduction of WQ in tunnel	Same	Same					
No impact Potential negative impact from poor water quality	No impact Same	No impact Same	No impact No impact	No impact No impact	No impact No impact	No impact No impact	No change No change
No impact	No impact	Loss of wetland habitat	No impact	No impact	Preserves marsh habitat	No impact	Possible loss of habitat
Same	Same	Same	Same	No impact	No impact		
None	None	None	Temporary relocation during flood events	Prevent temporary relocation during floods	Same	Same	Relocation associated with highway construction
Same	Same	Same	No impact	No impact	No impact	Documentation will preserve record of canal	Loss of structure through natural degradation
Temporary loss of use of ballfield at Pond Street			No impact	Stabilize reservoir for passive use	Preserve marsh habitat for passive use	No impact	Improvement to existing program
Same	Same	Same	Promote cooperation during flooding	Eliminate threat of flooding in residential area	No impact	No impact	
Same	Same	Same	No impact	No impact	Maintains open space		No impact
Construction traffic on *School St.*, *Pond St.*, Southern Artery	Same	Same	Streets closed during flooding MBTA affected	Traffic disruption on Lakeside Drive	No impact	No impact	Streets closed during flooding MBTA affected
Same	Same	Same					
Same	Same	Same	Evacuation of residents during flood events	Improve safety of dam	No impact	No impact	No change

Accounts	Relief Conduit & Town River Channel & Southern Artery Culverts	Relief Tunnel (15') & Relief Tunnel (8') & Southern Artery Culverts	Relief Tunnel (12') & Southern Artery Culverts	Town River Channel & Southern Artery Culverts	Nonstructural (Flood Proofing)	Old
4. Regional Development (RD) Tax Revenue	Stable	Stable	Stable	Stable	Stable	Sta
Property Value	Increased value in flood protected areas	Same	Same	Same	No impact	No
Local Government finances	Reduced expenditures for flood emergencies	Same	Same	Same	No impact	Sam
Public Facilities & Services	Provide flood protection for transportation facilities	Same	Same	Same	No impact	Sam
Employment/Labor Force	Provide construction jobs for 2 years	Same	Same	Same	Temp. loss during floods	Sam
Business and Industrial Activity	Enhanced by providing flood control	Same	Same	Same	Temp. loss during flooding	No
C. Plan Evaluation						
1. Contribution to Planning Objectives						
a. Reduce flood damages	Eliminate nearly all flood damages	Same	Same	Same	Partial reduction of flood damages	Red from ove
b. Preserve smelt spawning area	No impact	No impact	No impact	No impact	No impact	No
c. Preserve Town River salt marsh	Channel excavation would destory wetland	No impact	No impact	Channel evacuation in in lower reach of wetland	No impact	No
2. Net (with vs without) beneficial and adverse effects						
a. NED	+$322,000	+$563,000	+$278,000		-$74,000	-$2,
b. EQ	Loss of salt marsh	No impact	No impact	Partial loss of salt marsh	No impact	Sta res
c. SWB	Reduction of flooding	Same	Same		No impact	No
d. RD	Enhances growth potential	Same	Same	Same	Reduces economic risk	No
3. Plan Response						
a. Acceptability	Not acceptable	acceptable	acceptable	Loss of salt marsh not acceptible	Not acceptable	Acc
b. Completeness	Requires construction of local drainage	Same	Same	Same	Complete in itself	Same
c. Effectiveness	Effective	Effective	Effective	Effective	Least effective.	Eff
d. Certainty	Implementation assures flood reduction	Same	Same	Same	Implementation dependent on individual properties	Cert
e. Reversibility	Should be considered irreversible	Same	Same	Same	Reversible if use of measures is stopped	Irre
f. Stability	High	High	High	High	Low	High
d. Implementation Responsi-	Corps of Engineers Commonwealth of Mass. City of Quincy	Same	Same	Same	Corps of Engineers Commonwealth of Mass. City of Quincy, Town of Braintree, Property Owners	Corp nee weal City Town

	Relief Tunnel (15') & Relief Tunnel (8') & Southern Artery Culverts	Relief Tunnel (12') & Southern Artery Culverts	Town River Channel & Southern Artery Culverts	Nonstructural (Flood Proofing)	Flooding Old Quincy Reservoir Improvements	Easements On Salt Marsh	A&H Documentation of Canal Remains	Without Project Condition
	Stable	Stable	Stable	Stable	Stable	5 acres of wetland removed from tax rolls	No impact	Stable
	Same	Same	Same	No impact	No impact	No impact	No impact	No change
	Same	Same	Same	No impact	Same as tunnel	No impact	No impact	No change
Lee	Same	Same	Same	No impact	Same as tunnel	No impact	No impact	No change
	Same	Same	Same	Temp. loss during floods	Same	No impact	No impact	No change
	Same	Same	Same	Temp. loss during flooding	No impact	No impact	No impact	Continued strong activity
	Same	Same	Same	Partial reduction of flood damages	Reduce flooding from reservoir overflows	No impact	No impact	Ave. annual damage of $1.8 million
	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No change
	No impact	No impact	Channel evacuation in in lower reach of wetland	No impact	No impact	Will preserve salt marsh	No impact	Possible future encroachment
	+$563,000	+$278,000		-$74,000	-$2,000			
	No impact	No impact	Partial loss of salt marsh	No impact	Stabilized reservoir level	Preserve salt marsh	Historical record of Town Brook Canal	
	Same	Same		No impact	No impact	No impact	No impact	No impact
	Same	Same	Same	Reduces economic risk	No impact	No impact	No impact	No impact
	acceptable	acceptable	Loss of salt marsh *not acceptible*	Not acceptable	Acceptable	Acceptable	Acceptable	
	Same	Same	Same	Complete in itself	Same	Same	Same	
	Effective	Effective	Effective	Least effective.	Effective	Effective	Effective	Effective
	Same	Same	Same	Implementation dependent on individual properties	Certain	Certain	Certain	
	Same	Same	Same	Reversible if use of measures is stopped	Irreversible	Reversible	Irreversible	
	High	High	High	Low	High	High	High	
	Same	Same	Same	Corps of Engineers Commonwealth of Mass. City of Quincy, Town of Braintree, Property Owners	Corps of Engineers, Commonwealth of Mass. City of Quincy, Town of Braintree	Same as tunnel	Same as tunnel	

Table B-2

EVALUATION OF ALTERNATIVE TUNNEL OUTLETS

The object of the relief tunnel is to divert excess floodflows from upstream of the damage areas, bypass the damage area and outlet the diverted water where it will cause no economic or environmental damages. For the Town Brook tunnel seven alternative tunnel outlets were considered, located as shown in Figure B-1. Three of the outlets are located to discharge into Town River upstream of the Southern Artery. Four locations were studied with discharges into Town River Bay.

Description of Outlets

Alternative 1 - The outlet is located adjacent to the salt marsh at the downstream end of the Town River wetland area. The tunnel length would be 4060 feet. A 400-foot connector channel, 50 feet wide, ties the tunnel outlet to the Town River. No excavation in the salt marsh habitat is needed. Hydraulic analysis indicated that adequate cross sectional area exists in the downstream end of the marsh to carry design floodflows. As a safety factor, flowage easements or purchase of the wetland should be required to prevent encroachment on this floodway.

Since this tunnel outlet is located upstream of the Southern Artery rebuilding of the culverts under this road and adjoining parking lot is necessary. The wider channel would allow more seawater to flow inland, but the addition of flap gates at the box culvert would restrict the flow to previous levels.

A 2-acre construction site and access to that site is available by way of a ballfield and existing filled marsh area.

Alternative 1A - This outlet was located adjacent to the supermarket parking lot at the most downstream point of the Town River wetland. This location was analyzed to lessen the impacts on the marsh. Only a very short connector channel is needed. The other project features are the same as Alternative 1. A tunnel length of 4,750 feet is needed.

Alternative 1B - This outlet is located on the left bank of Town River downstream of the Southern Artery. The required tunnel length is 5,170 feet. This location of the outlet avoids all impact on the marsh and eliminates the need for new culverts under the Southern Artery.

The work area would be on the grounds of a privately owned business and would be adjacent to the Southern Artery.

Alternative 2 - This outlet alternative is located on the right bank of Town River at the upstream end of the salt marsh area. At this location the excavation of a 50-foot wide channel is needed through much of the marsh to carry design flows. A 100-foot connector channel through the marsh is needed to tie the outlet to the channel. A tunnel length of 3,580 feet is needed to reach this outlet. This location requires the same project features at the Southern Artery.

The work area would be located adjacent to a residential area and in the salt marsh itself. The area available is limited and access is restricted by the residential area.

Alternative 3 - This outlet alternative is located across Town River Bay on the City of Quincy Department of Public Works storage yard. A 5,730-foot long tunnel is required to reach this outlet. The outlet site is on filled land and would require a short connector channel to the bay. Adequate work area is available away from residential and business areas.

Alternative 3A - This outlet is located on Town River Bay in the parking lot of a trucking company. The required tunnel length is 5,330 feet. The outlet could be located adjacent to the bay. Adequate work area and access is available at the expense of the business.

Alternative 4 - This alternative is located on Town River Bay and requires a 5,250-foot tunnel. Adequate work area and access are available, but again on land now used for private business. The outlet could be located adjacent to the bay.

TABLE B-3

PRELIMINARY ANALYSIS OF ALTERNATIVE TUNNEL OUTLETS
(1st Screening)

	1	1A	1B	2	3	3A	4
Benefits (Ave. Ann.)	1,766,000	1,766,000	1,766,000	1,766,000	1,766,000	1,766,000	1,766,000
First Costs ($1,000,000)	15.9	17.3	17.6	15.0	18.1	17.5	17.9
Salt Marsh	No Impact	No Impact	No Impact	Channel Ent.Lngth	No Impact	No Impact	No Impact
Residential Area	Nearby	Nearby	No Impact	Adjacent	No Impact	No Impact	No Impact
Business	1 Relocation	1 Relocation	1 Relocation	1 Relocation	No Impact	1 Relocation	1 Relocation
Access to Work Area	OK	OK	OK	Poor	OK	OK	OK
Southern Artery Disruption	Yes	Yes	No	Yes	No	No	No
Impact on Historic Feature	Yes	Yes	No	Yes	Yes	No	No
Work Area	Adequate	Limited	Adequate on Maj.Rd.	Limited	Adequate	Adequate	Adequate
Recreation Area	Temp.Disrup	Temp.Disrup.	No Impact	Temp.Disrup.	No Impact	No Impact	No Impact
Tunnel Length (Feet)	4,060	4,750	5,170	3,850	5,730	5,330	5,290
Channel Work Below So. Artery	Yes	Yes	Yes	No	No	No	No

Preliminary Screening

The study located seven potential outlets for the relief tunnel and preliminary assessment and evaluations were completed. From the seven, the following three alternative outlets were selected for more detailed analysis:

1. Alternative 2 because it was the least expensive.

2 Alternative 3 because it appeared to be the least environmentally disruptive, although it has the highest cost.

3. Alternative 1 because it eliminated the major environmental concerns of Alternative 2 and was only 6 percent more expensive.

These three outlets were evaluated in more detail. Detailed cost and real estate analysis are shown in Appendices F and J. The summary of impacts used in the first screening applies. The revised costs for relief tunnel alternatives are as follows:

TABLE B-4

EVALUATION OF ALTERNATIVE TUNNEL ALIGNMENTS

Item	Tunnel Alternative 1	2	3
Tunnel Cost	$12,840,000	$11,036,000	$18,033,000
Town R. Improvements	1,363,000	1,710,000	82,000
Subtotal	14,203,000	23,746,000	18,115,000
Engr. & Design (10%)	1,420,000	1,275,000	1,812,000
S&A 7%	995,000	892,000	1,268,000
Subtotal	2,415,000	2,167,000	3,080,000
Real Estate	1,363,000	1,710,000	82,000
Total First Cost	$17,981,000	$16,623,000	$21,277,000

Comparison of Tunnel Outlets

The least cost tunnel alignment is Alternative 2. The environmental and social problems associated with this alternative are disruptive and not acceptable. The major impact is the need to widen 2,000 feet of Town River Channel and virtually eliminate the salt marsh. Access to the proposed tunnel outlet and work area would be through a residential area and convalescent home. The work area itself would be adjacent to these homes and construction activities would create a major impact. Filling of the marsh would be required to create a suitable work ares.

Alternative 1 costs $1.3 million more than Alternative 2. Analyses indicate that with the tunnel outlet at the lower end of the marsh adequate flow area exists and no channel work in Town River is required. A connector channel from the outlet to the marsh requires about a 1/2 acre of filled land. There is adequate access to the work area through a city owned playground area. Adequate work area exists and is away from residential areas.

Both Alternatives 1 and 2 require the construction of new culverts under the Southern Artery and an adjoining supermarket parking lot. Construction will disrupt Southern Artery traffic, but with staged construction, peak traffic flows can be handled.

Construction of the culverts will also disrupt the parking lot of the supermarket located on the Southern Artery. At worst, this could put the market out of business requiring purchase of the property. Following construction the supermarket would revert back to private ownership. Alternatives to this relocation are to provide other parking and construct the culverts in stages.

Downstream of the Southern Artery, Alternatives 1 and 2 require the widening of Town River. This will require the partial removal of the remains of a lock and dam of the former Town Brook Canal. The initial impact to the structure will be negative. This loss can be mitigated by providing documentation, for historic purposes, of the lock and dam. This could turn out to be a positive impact since the documentation will preserve this site on record, whereas it would probably be lost through the natural deterioration process.

Alternative 3 has its outlet in Town River Bay and avoids many of the impacts associated with Alternatives 1 and 2. It is the most costly at $4.7 million more than Alternative 2. The outlet is located on city of Quincy storage area and this is less disruptive than the other sites.

Selected Tunnel Outlet for Detailed Evaluation

Alternative 1, with an outlet at the lower end of the Town River wetland was selected for detailed planned analysis. Alternative 2 is unacceptably disruptive even though it is the least costly. Alternative 3 is the least environmentally disruptive but is the most expensive. The impacts associated with Alternative 1 are not major or are short term in duration and the cost savings over Alternative 3 are significant ($3.3 million). Alternative 1 offers an acceptable compromise between the most economical and the least environmentally disruptive.

SOCIAL AND ECONOMIC CONSIDERATIONS

Alternative measures were investigated to determine how well they met the objective of providing flood protection in Quincy. The first iteration eliminated alternatives which were impracticable in Quincy. These included such measures as controlling the land runoff through land treatment or conservation and confining the flow with levees or floodwalls. Some nonstructural measures also proved to have limited applicability to the situation in Quincy.

Those alternatives surviving the first iteration underwent a more detailed examination of social, economic and environmental issues at a preliminary level. The structural measures assessed during the second iteration included impoundment of floodwaters, improvement of channel capacity, and bypass of flow.

STRUCTURAL ALTERNATIVES

Impoundment of Floodwaters

The Old Quincy Reservoir is the only reservoir in the Town Brook watershed. Originally built for water supply, it now supplies industrial water to General Dynamics. Raising the dam to provide additional storage for flood control was considered, but the site is already developed almost to its physical limits and very little additional storage is possible.

Construction-related effects would be temporary and "typical" of heavy construction activities. These effects are increased noise, air pollition, dust and heavy truck traffic. Positive economic impacts would result from temporary jobs generated by the construction activity and increased business in the area. Some of these benefits would accrue to local businesses. Access to the project site, because of its physical limitations, is through residential areas. This increases health and safety risks, because Lakeside School is located directly opposite the reservoir site.

The major long term effects of reservoir modification would be the reinforcement of the dam to assure its structural integrity and the flood protection offered to the Lakeside Street area. Local opposition was voiced regarding aesthetic considerations and the disruptive influence the project would have on this residential area.

Since raising the dam did not appear acceptable, options to increase personal safety and eliminate flooding along Lakeside Street were investigated. Through this investigation a plan consisting of a new spillway structure with increased capacity, a dike along the left shoreline, and a new low level control structure was developed.

Implementation of this plan would result in many of the same construction-related impacts that would be experienced if the dam were raised. In the long term, economic losses to residents and threat to safety and health of residents and school children in the reservoir area would be reduced.

Improvement of Channel Capacity

To increase channel capacity through downtown Quincy, construction of a box culvert was considered. The culvert would be capable of handling 100-year flows through the central business district and downstream to Town River. The inlet structure for the culvert would be located behind the Star Market near School Street. The culvert would then run beneath the MBTA Redline tracks and turn northward to the proposed Crosstown Connector, which it would follow along Revere Road and McGrath Highway until it reaches Town River.

Significant impacts would be felt during the construction period. These would be lessened if the project and the Crosstown Connector were constructed. Otherwise, placement of the culvert would interfere with the normal flow of traffic and people in the central shopping district. Some ecnomic losses would be felt by commercial establishments whose business activities would be disrupted. The culvert would have the "typical" construction-related effects already mentioned. The area is both residential and commercial and is particularly sensitive to construction activity because of its high intensity use. During construction, traffic would be rerouted around the Revere Road area, increasing traffic along residential streets to the east and in the commercial area west of Revere Road. It is also possible that the placement of the culvert would require more width than that offered by Revere Road and would require the taking of some private property. It is uncertain whether this would require relocation of any structures.

Channelization work along Town Brook is also required, which subjects another area to construction-related inconveniences. With channelization, culverts beneath the Southern Artery would have to be enlarged to carry the increased flows, creating significant traffic inconveniences along the Southern Artery which is heavily used, especially during commuter hours. Activity along Town River would restrict use of the Monroe Playground during the construction period. Of special concern is a discount supermarket whose business would be disrupted because the new conduits would pass beneath the store's parking lot.

Over the long term, this alternative would provide protection against the 100-year flood event and would eliminate the personal and economic risks faced by residents and businesses in downtown Quincy. Long term effects of construction activity could be possible relocations of structures along the culvert route or the supermarket on the Southern Artery. Although the flood control protection would not be directly responsible for new downtown development, it would certainly complement and enhance the development opportunities.

Bypass Tunnel

The use of a tunnel to bypass floodflows was another alternative worthy of consideration. Several options for inlet and outlet sites were investigated.

Basically, there were two sites that appeared feasible for an inlet structure. One tunnel entrance was located near School Street behind the Star

Market. The other tunnel entrance was located farther south, near the intersection of Water Street and Quincy Avenue. Creation of the tunnel inlet would result in many of the same construction impacts at either location. The inlet site would be subjected to increased air and noise pollution and the presence of heavy construction equipment. A work area approximating a third-acre would be needed during the construction phase.

Numerous tunnel outlets were considered with three outlet sites being addressed during the intermediate iterations. The three sites are located at 1) the Town River Marsh downstream from Elm Street, 2) the lower end of the wetland, and 3) the city landfill site.

Site 1 is located in a residential area which would be affected by construction of the outlet. It is expected that the tunnel would be excavated by drilling and blasting. Material excavated from the tunnel would be trucked to a land disposal site or placed on barges and towed to sea. Its outlet site at the junction of the brook and Town River would require extensive channel work for the entire length of the river. This construction activity, like that for the culvert, would temporarily interfere with use of the Monroe Playground.

Site 2 is located in the same general area as Site 1, but would have an outlet at the lower end of the Town River wetlands. Although extensive channel work is not required, temporary construction easements and activity would still inconvenience residents in the area and limit full use of the Monroe Playground.

Both sites 1 and 2 would require the placement of new culverts under the Southern Artery to handle the increased flows. New culverts would also be placed beneath the parking lot of the Hi-Lo grocery market that fronts the Southern Artery. This interference may require a relocation of the business.

Site 3 is on city-owned, hydraulically filled land. Although this site would require the longest tunnel, it would not disrupt any residential or commercial activities. The fill area itself may be utilized as a disposal site for the material removed from the tunnel, minimizing the potential transportation problems and risks of using a more distant disposal site.

The most significant long term effect of the tunnel would most obviously be flood protection. This tunnel alternative, including channel and culvert work at the outlet, would be able to handle flows equivalent to those of the 100-year event. The inlet and outlet structures would require 5.64 acres in permanent easements. As with the culvert alternative described prevously, the tunnel would complement the downtown revitalization plans by reducing the flood risk.

NONSTRUCTURAL ALTERNATIVES

Nonstructural alternatives are measures that generally attempt to keep people and structures out of the flood plain through regulation rather than flood control structures that keep water away from people and development. Nonstructural measures have limited applicability in Quincy, since its flood-prone areas are already intensively developed. Several flood proofing methods

as well as a flood forecasting and warning system and flood insurance were investigated for their feasibility in Quincy.

Flood Proofing

Floodproofing measures prevent water from entering a structure by installing temporary or permanent closures at its openings, raising existing structures, or enclosing structures and property with small walls and dikes. Other measures of a more limited scope may also be considered flood proofing. These include rearranging damageable property within a structure or protecting mechanical and electrical equipment by constructing a utility cell.

Flood proofing, therefore, can be effective in reducing flood damages to structures contents. However, flood proofing of individual structures or even groups of structures could leave isolated occupants without utility services and transportation access.

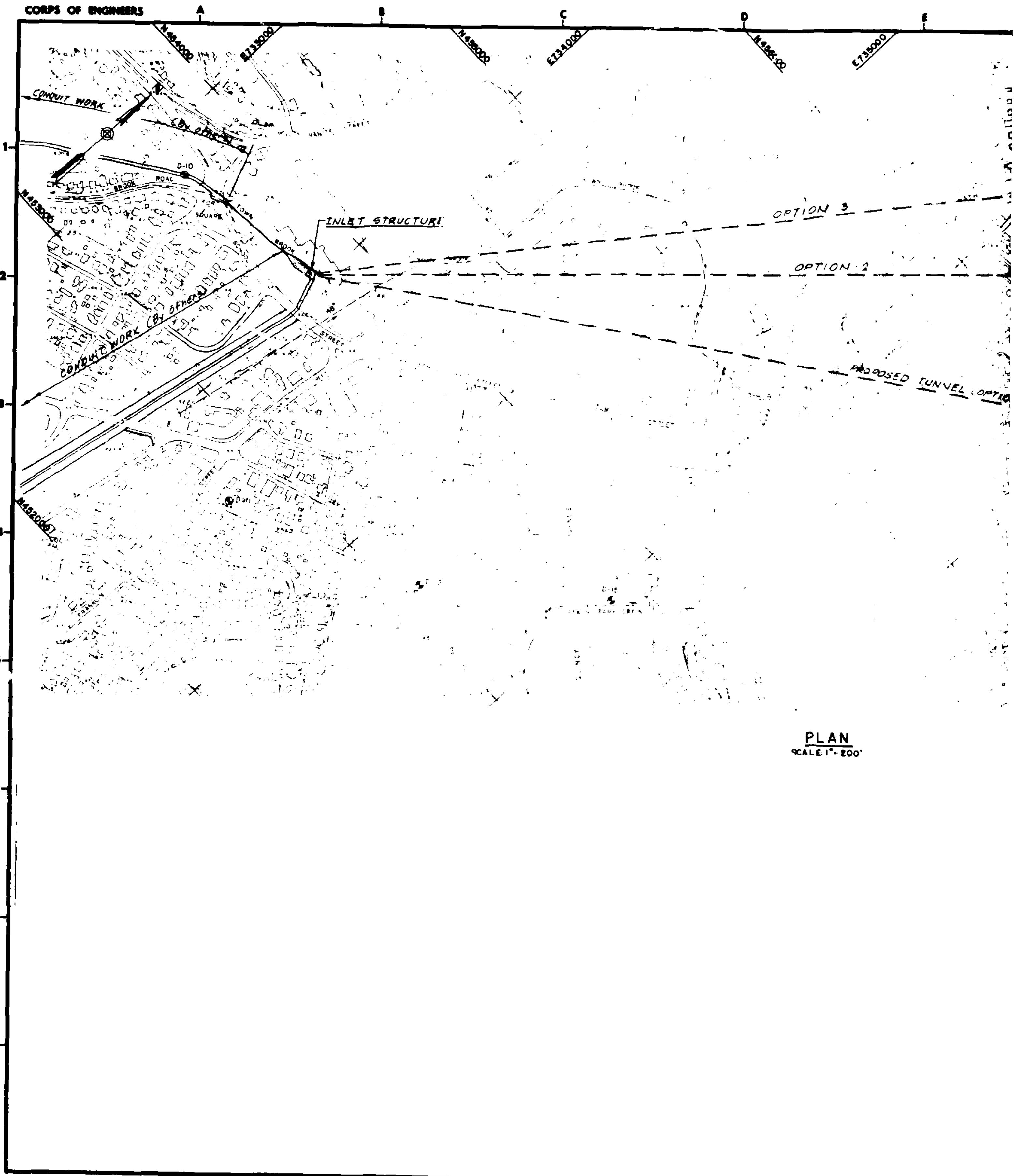
Flood Forecasting, Warning and Evacuation

A flood forecasting, warning and evacuation system has some applicability in just about every flood situation. The emphasis of such a system is the protection of lives. An effective flood warning system would permit residents to secure movable, damageable possessions, moving their cars outside of the area for example. Warning would also give residents some advance notice of evacuation if warranted by the flood situation. A flood warning/evacuation program can enhance the well-being of community residents. Although this alternative protects the lives of the flood plain residents, homes and businesses would continue to be vulnerable to flooding as described in the without condition section.

Flood Insurance

Quincy is currently enrolled in the National Flood Insurance Program administered by the Federal Emergency Management Agency. Through this program, the Federal Government makes available insurance coverage for existing development in flood hazard areas through a consortium of private insurers at subsidized rates. Flood insurance modifies the impact of flooding by distributing the costs more evenly over time and by allocating the costs of flooding to those exposed to a wide range of flood risks.

The program also has built into it a regulatory requirement which helps to reduce future flood damages by restricting types of development that may be permitted within flood hazard areas.



PLAN
SCALE 1" = 200'

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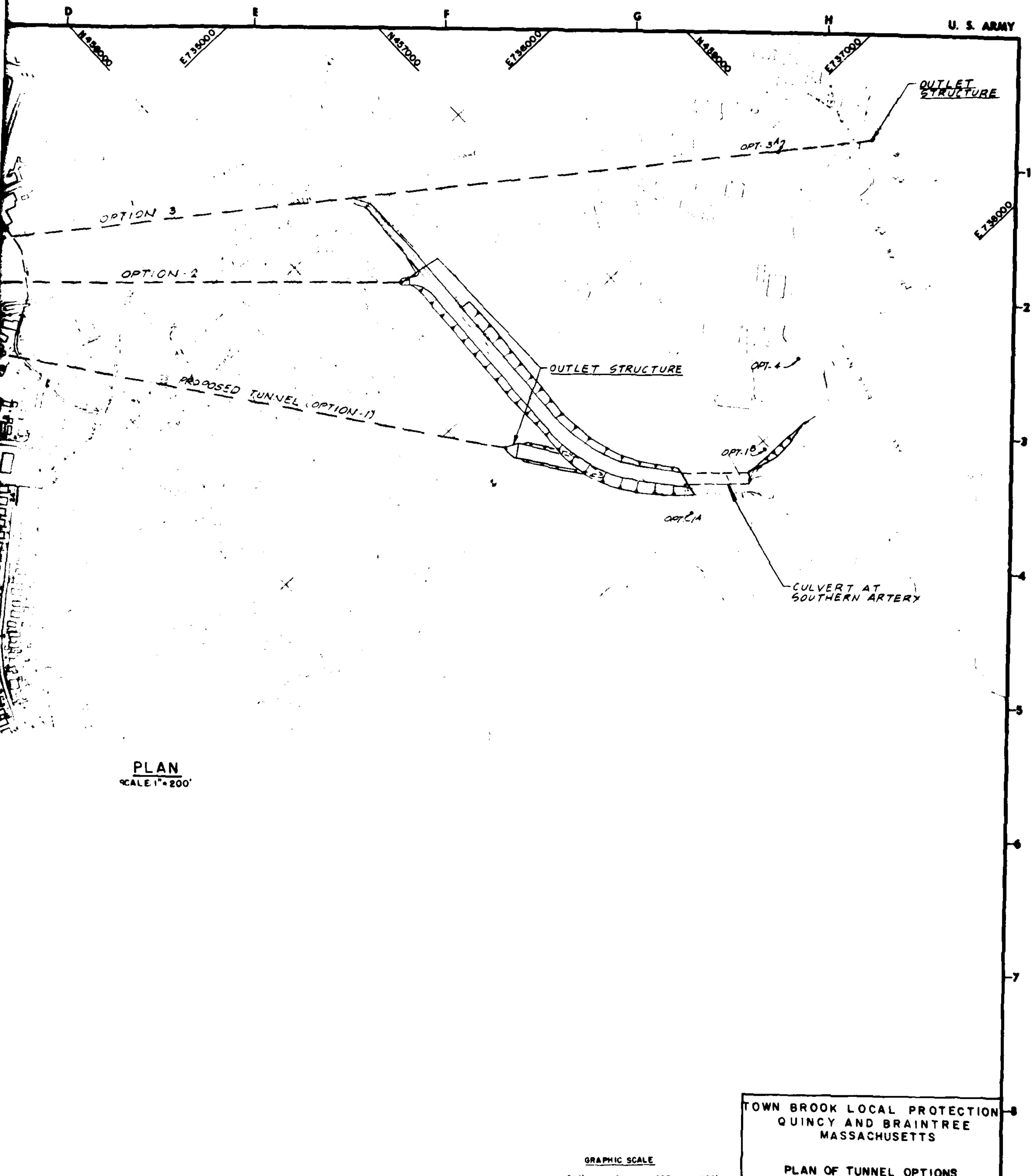

TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

PLAN OF TUNNEL OPTIONS

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

FIGURE B-1

Appendix C

Public Views and Responses

APPENDIX C
PUBLIC VIEWS AND RESPONSES

TABLE OF CONTENTS

PUBLIC INVOLVEMENT

- Objectives
- Public Meetings
- Coordination Meetings
- Pertinent Meetings of Others

SUPPORT AND COORDINATION CORRESPONDENCE

PERTINENT NEWSCLIPS

PUBLIC REVIEW COMMENTS

APPENDIX C

PUBLIC INVOLVEMENT

OBJECTIVES

In the broadest sense, the "public" consists of non-Corps of Engineers entities, Federal, State, local and regional agencies as well as public and private organizations, and individual citizens. The public participation program is intended to provide a continuous two-way communication process which will maximize the opportunity for the public to (1) be involved in the overall planning process, (2) be aware of the study progress; and (3) make decisions that would have impacts on the lives of those in the study area. Inasmuch as major decisions made throughout the study will be based upon expressed needs of local, county, state and regional officials as well as the general public, it is necessary to establish a mechanism to channel information to interested participants and to funnel their responses to those conducting the study.

PUBLIC MEETINGS

Prior to the authorization of this study, on 6 January 1970 at the request of the Mayor of Quincy, Corps representatives attended an open meeting with local officials and the newly appointed Flood Control Commission. About 50 Quincy citizens were also in attendance. The meeting was held to discuss flood problems in south Quincy and Quincy Point. As a result of this meeting, the Mayor of Quincy sent a letter dated 7 January 1970 to the Corps requesting assistance with the local flooding problem.

Since the authorization of this study the Corps has been involved with three public meetings. The first meeting held on 8 June 1972 was a review of flood control and allied purposes for city of Quincy, Massachusetts coastal streams, specifically Furnace Brook, Town Brook, and Hayward Creek. The purpose of this meeting was to solicit public opinion concerning existing problems and needs of the study area. Information received was later used to formulate the planning objectives for the study. Nearly 100 persons attended the meeting. The large turnout and the numerous comments expressed pointed to the public concern about the flood situation. Several speakers urged immediate construction of flood control improvements. Others made proposals for regulating the level of Old Quincy Reservoir to provide downstream flood control. However, owners of shore properties around the reservoir cautioned against excess drawdown which might create adverse effects on the environment. Many speakers urged channel improvement for flood control. Opposition was voiced to further flood plain development with its consequent increases of runoff. Most of the residents were concerned with eliminating flooding and damages to residential properties in low lying areas. Local, State and Federal officials also expressed concern and proposed plans for improvement.

The second public meeting was held in cooperation with the Metropolitan District Commission (MDC) on 11 December 1975 and dealt specifically with the Town Brook watershed. The purpose of the meeting was to air proposed solutions to flood problems, and receive comments from all interested parties. These comments were incorporated into the plan formulation and plan selection processes. The concerns which were brought out in the 1972 meeting again arose. In addition, concern over the stability of the Braintree Dam surfaced. During the meeting the town of Braintree endorsed the concept of a tunnel plan. The concept was also supported by a large number of the individuals in attendance. Again the people at the meeting urged that construction of flood control improvements move along as quickly as possible.

On 18 September 1980 a third public meeting was held to present the selected plan to the public and receive their comments on it. The meeting was attended by approximately 50 individuals. Many of those attending were local civic leaders. Various individuals emphasized the damages inflicted on the community by flooding from Town Brook. During the course of the meeting many attendees issued their support for the project. Those issuing their support included a State representative, the president of the Quincy Ward II Civic Association, local businessmen, a chapter of the American Legion, the city councilman from Quincy's Ward II and various citizens representing only themselves. The only questions which arose concerned the projects timetable and costs.

COORDINATION MEETINGS

Since the 1975 public meeting the Corps has had several coordination meetings with various non-Federal interests. On 4 March 1977 members of the New England Division (NED) met with MDC, Massachusetts Department of Public Works, the Massachusetts Bay Transit Authority (MBTA), Federal Highway Administration and the Quincy Planning Department. The principal item of discussion involved the coordination and timing of the construction of the MBTA station at Quincy and the Town Brook flood control project. Members of NED met with the Flooding Committee of the South Quincy MBTA Task Force on 15 July 1977. The purpose of this meeting was to answer questions concerning the Town Brook study and future scheduling. On 7 April 1978 another Town Brook coordination meeting was held. This meeting was held so that all parties concerned with Town Brook would have a general understanding of what the others were doing. The meeting was attended by the State Representative from Braintree and representatives from Massachusetts Department of Public Works, the town of Braintree, MDC, the city of Quincy, the Braintree Star, and the MBTA.

Through continuing coordination with the U.S. and Massachusetts Fish and Wildlife Services key environmental problems, needs, and opportunities were identified. The principal environmental resources that might be affected by a flood control project are smelt spawning runs and salt marshes.

PERTINENT MEETINGS OF OTHERS

A public meeting was held by the Massachusetts Department of Public Works on 20 February 1980 to obtain local comment on a plan to extend the Burgin Parkway. A part of the plan is to construct a deep flood control culvert which will parallel the parkway extension and carry flood waters away from South Quincy. An important aspect of the flood control part of the parkway extension plan is the completion of flood control feasiblity studies, by the Army Corps of Engineers. Residents are worried that without a total flood protection plan the culvert will increase local flooding.

SUPPORT AND COORDINATION CORRESPONDENCE

City of Quincy, Massachusetts

City Hall

OFFICE OF THE MAYOR

ARTHUR H. TOBIN

October 20, 1980

Colonel Max B. Scheider
U.S. Army Corp. of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Col. Scheider:

The City of Quincy has long been in favor of the flood control studies on Town Brook. The city supports the selection of a local protection plan which consists of a relief tunnel to divert flood flows away from residential and business districts in Quincy, the larger culverts under the Southern Artery, and improvements to the Old Quincy Reservoir. We request that you recommend this plan for authorization for construction.

The city is willing to participate in the construction of the project and agrees to the following general assurances of local cooperation as they apply to Quincy.

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and maintenance of the project.

b. Hold and save the United States free from damages due to construction of the works, except damages due to fault or negligence of the United States or its contractors.

c. Maintain and operate all works, including Braintree Dam and its appurtenant structures, after completion in accordance with regulations prescribed by the Secretary of the Army.

d. Provide without cost to the United States all alterations and replacements of existing utilities, and construct certain culverts and pavements.

e. Prescribe and enforce regulations to prevent encroachment on both the improvements and unimproved channels, and manage all project-related channels to preserve capacities for local drainage as well as for project functions.

f. Comply with the provisions under Section 210 and 305 of Public Law 91-646, 91st Congress, approved 2 January 1971 entitled "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

City of Quincy, Massachusetts
City Hall

OFFICE OF THE MAYOR

ARTHUR H. TOBIN

Colonel Max B. Scheider October 20, 1980
U.S. Army Corp. of Engineers

We also wish to make it clear that our support for the project is based on the provisions of the existing cost-sharing legislation. If the project is authorized according to the President's cost sharing proposal, we may wish to reconsider our decision.

Sincerely yours

ARTHUR H. TOBIN
Mayor

AHT/mc
cc: Commissioner James J. Ricciuti
Department of Public Works
City of Quincy

The Commonwealth of Massachusetts
Metropolitan District Commission
20 Somerset Street, Boston 02108

Colonel Max B. Scheider
Division Engineer
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Mass., 02154

September 23, 1980

Dear Col. Scheider:

The Metropolitan District Commission (MDC) of the Commonwealth of Massachusetts is presently active in drainage and flood control works in the Town Brook watershed. The MDC supports the selection of a local flood protection plan which includes a relief tunnel, culverts under the Southern Artery, and improvements to the Old Quincy Reservoir. This plan ties in well with the projects of the MDC and others, and we request that you recommend this plan for authorization for construction.

The MDC is willing to participate in the construction of the project and agrees to the following general assurances of local cooperation:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and maintenance of the project.

b. Hold and save the United States free from damages due to construction of the works, except damages due to fault or negligence of the United States or its contractors.

c. Maintain and operate all works and appurtenant structures, as appropriate, after c[illegible]ion in accordance with regulations prescribed by the Secretary of the Army.

d. Provide without cost to the United States all alterations and replacements of existing utilities, and construct certain culverts and pavements.

e. Prescribe and enforce regulations to prevent encroachment on both the improvements and unimproved channels, and manage all project-related channels to preserve capacities for local drainage as well as for project functions.

f. Comply with the provisions under Section 210 and 305 of Public Law 91-646, 91st Congress, approved 2 January 1971 entitled "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

We wish to make it clear that our support for the project is based on the provisions of the existing cost-sharing legislation. If the project is authorized according to the President's cost sharing proposal, we may wish to reconsider our decision.

Very truly yours,

Martin Weiss

Martin Weiss
Chief Engineer
Metropolitan District Commission

MW/hmm

THE

TOWN OF

BRAINTREE

OFFICE OF SELECTMEN

TELEPHONE
848-1870

ONE JOHN FITZGERALD KENNEDY MEMORIAL DRIVE
BRAINTREE, MASSACHUSETTS 02184

September 22, 1980

Colonel Scheider
U. S. Army Corps of Engineers
Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Scheider:

The Town of Braintree has long been in favor of the flood control studies on Town Brook. The Town supports the selection of a plan which includes improvements to the Old Quincy Reservoir because of the flood protection and safety this will provide to residential areas downstream of the reservoir. We request that you recommend for construction authorization the plan as described in Town Brook feasibility report.

The Town is willing to cooperate in the construction of the project and agrees to the following general assurances of local cooperation as they apply to Braintree.

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and maintenance of the project.

b. Hold and save the United States free from damages due to to construction of the works, except damages due to fault or negligence of the United States or its contractor.

c. Maintain and operate all works, including Braintree Dam and its appurtenant structures, after completion in accordance with regulations prescribed by the Secretary of the Army.

d. Provide without cost to the United States all alterations and replacements of existing utilities, and construct certain culverts and pavements.

e. Prescribe and enforce regulations to prevent encroachment on both the improvements and unimproved channels, and manage all project-related channels to preserve capacities for local drainage as well as for project functions.

f. Comply with the provisions under Section 210 and 305 of Public Law 91-646, 91st Congress, approved 2 January 1971 entitled "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

We wish to make it clear that our support for the project is based on the provisions of the existing cost-sharing legislation. If the project is authorized according to the President's cost sharing proposal, we may wish to reconsider our decision.

Any encumbrance of Town funds are naturally contingent on appropriation at Town Meeting.

Very truly yours,

Robert R. Sherman

Robert R. Sherman
Executive Secretary/Administrator

RRS:egd

Copy to Town Engineer
Town Counsel
Highway Department
Conservation Commission

City of Quincy
Massachusetts

Office of the Mayor

James R. McIntyre
Mayor

June 20, 1969

Colonel Frank P. Bane
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Bane:

It is requested that the Corps of Engineers initiate a reconnaissance study of brooks and streams in the City of Quincy, under the Section 205 Authority.

Primary flooding problems are located along Furnace Brook, Town Brook, Black's Creek, tidal outlets and sea walls.

Your cooperation in this matter would be deeply appreciated.

Very truly yours,

James R. McIntyre

James R. McIntyre

jrm/b

City of Quincy
Massachusetts
Office of the Mayor

James R. McIntyre
Mayor

January 7, 1970

Colonel Frank P. Bane
United States Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Colonel Bane:

In view of the recent flooding conditions in the City of Quincy, which were incurred on the evenings of December 26 and December 27, 1969, it is requested that the Army Corp of Engineers review previous studies which have been made in our city and the analysis of flooding problems in Quincy, which report was submitted to me in September, 1969.

We are hopeful that a review of this report would result in a significant flood alleviation system from the United States Government to the City of Quincy, so that many of the homes that were flooded and damaged can be averted in the future.

In addition, it is requested that there be an investigation by the Army Corps of Engineers of the possible diversion of a tributary of the Furnace Brook in the Cunningham Park of the Town of Milton into the Neponset River, which would also result in flood alleviation benefits for the City of Quincy and an area in the Town of Milton.

Thank you for your consideration to this request.

Very truly yours,

James R. McIntyre

JAMES R. McINTYRE

JRM:pms
Copies to: Boston Globe
Radio Station W.J.D.A.
Patriot Ledger

The Commonwealth of Massachusetts

House of Representatives

State House, Boston

ROBERT A. CERASOLI
REPRESENTATIVE
1st NORFOLK DISTRICT
2? WHITON AVENUE
QUINCY 02169
Home Tel. 471-3859

July 14, 1976

COMMITTEE ON
ELECTION LAWS
STATE HOUSE, BOSTON
ROOM NO 26
Tel 727-8215

Colonel Ralph T. Garver
Acting Division Engineer
Department of Army
New England Division
Corps of Engineer
424 Trapello Road
Waltham, MA 02154

Dear Colonel Garver:

I am writing to you relative to the proposed Town Brook Watershed Flood Control Project.

The immediate and critical need of this project is obvious. The Flood Control improvement for the Town Brook Watershed is a dire necessity for the public's welfare and safety, especially for the residents in the proposed South Quincy MBTA station area. Irrelevant of whether the MBTA station is built or not this project is still a public necessity. On December 11, 1975 the public meeting was held in Quincy to present preferred plans for flood control in the Town Brook Watershed, and to incorporate public needs and desires in the plan formulation.

The plan was supported by local citizen interest, and I made extensive testimony in favor of the MDC's preferred plan with suggested minor modifications. It is my belief that approximately 20 million dollars must be spent to institute the above mentioned plan. This figure alone is indicative of the severe problems that must be corrected in the South Quincy area. I would like to be informed as to what stage the formulation of this project is in. It is imperative that a report be issued in the near future, so that, we can all work together to gain the release of funds necessary to correct flooding problems in the Town Brook Watershed.

I will be happy to work with you in any way possible to see that my constituents in the South Quincy area are protected from future incidences of flooding.

Colonel Ralph T. Garver
Page 2
July 14, 1976

Hopefully we can work together to reduce flooding and eliminate the economic and personal losses caused by flooding in the South Quincy area.

Thank you for your kind consideration in this matter. I will be awaiting your reply.

Sincerely,

Robert A. Cerasoli

ROBERT A. CERASOLI
State Representative

RAC:jd

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. Box 1518
Concord, New Hampshire 03301

APR 27 1979

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This letter is intended to aid you in your planning for a local flood control project in Town Brook, Quincy and Braintree, Norfolk County, Massachusetts. A resolution of the Committee on Public Works of the United States House of Representatives, adopted December 2, 1970, directed that a study of flood control and allied purposes be conducted in the Quincy, Massachusetts, coastal area. Town Brook is one of three watersheds involved in the study. This report is submitted under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), to generally describe the fish and wildlife resources and review problems and opportunities in relation to the project.

Town Brook watershed is located a few miles south of Boston in Quincy and Braintree. A small section of the 3,000-acre watershed lies in the Blue Hills Reservation in Braintree. The brook then drains southeastward to the Old Quincy Reservoir. From the reservoir, Town Brook follows a generally northeastward course through densely populated sections of Quincy, then enters tidal waters through a small tidal wetland (known as Town River) and into Town River Bay, a tidal inlet tributary to Weymouth Fore River which is an arm of Hingham Bay, the southern lobe of Boston Harbor. The brook is about 3 miles long from the Old Quincy Reservoir to tidewater. About half the length is in underground conduits.

The purpose of the proposed project is to reduce flash flooding along the stream in the highly developed residential and commercial center of Quincy. The proposed project consists of modifications to the dam and providing for storage of floodwaters at Old Quincy Reservoir, construction of a deep tunnel under the lower part of the watershed to divert flood flows, installation of new diversion conduits, and enlarging the channel in some remaining open reaches of stream. Normal flows would continue to follow the existing stream, but flood flows (actually water surges resulting from heavy rains) of over 200 cfs would be diverted through the tunnel. The various new conduits would divert flood flows from existing reaches of open channels and conduits. Normal flows will remain in the existing waterway.

The 36-acre Old Quincy Reservoir (see A, attached map) was stocked with trout in 1966. It was found, however, that the high acidity of the water (pH 4.4-4.8) caused the loss of stocked fish.[1] No further efforts at fisheries management have been made.

Periodic storage of floodwater over the 50-year project life will have no impact upon the small population of yellow perch and bullhead in the reservoir. Terrestrial habitat around the shoreline will be inundated by floodwaters several times a year during the 50-year project life. This will cause temporary loss of wildlife habitat. Construction of a spillway and dike will have temporary adverse impacts upon wildlife habitat during the construction period.

The following discussion deals with what we consider to be the three areas of impact on fish and wildlife resources.

A wooded area (see B, attached map) of about 60 acres lies between Route 3, the granite quarries, and the Granite Branch Railroad line located on the west side of the Raytheon plant on Centre Street. The stream flows through part of this area forming a small wet site of about 10 acres.

The proposed diversion channel to be located upstream from the Granite Branch Railroad will require removal of vegetation, digging the channel, removal of spoil, cleaning up the area and replanting of vegetation. It will be a permanent disruption of the low-lying, wet portion of this wooded area. The diversion channel will be an open, artificial, intrusion in this site that still remains in a relatively natural condition. It is not a highly significant wildlife area in a broad scale, but the small mammals and songbirds that live there add to the human environment values of nearby residents.

There is a risk of changing the characteristics of the area by dredging a relief channel to carry floodwaters. Spring floodwater that spreads through the area helps to maintain its character. You should explore the possibility of constructing an overflow outlet at the railroad tracks instead of the diversion channel. The outlet should be designed to hold some of the floodwater in the wet area and it could be less expensive to construct than the diversion channel.

The stream from Revere Road to Bigelow Street is utilized by large numbers of rainbow smelt for spawning (see C, attached map). This run enters from Town River Bay, passing under a 250-foot culvert at the Southern Artery, through the tidal wetland channel, and then through about 1,700 feet of closed conduit before reaching the spawning area. The smelt spawn when water temperatures are between 50 and 60°F.[2] The peak of the spawning

[1]MA Division of Fisheries and Wildlife. Personal communication.

[2]Dupee, David S. and Michael Manhard. 1975. The Rainbow Smelt 'Osmerus mordax.' 1974. Spawning Run in the Town River, Quincy, MA, U.S. Army Corps of Engineers, New England Division.

has been reported to be between April 25 and May 2, and more smelt reach the area than can be accommodated by the spawning area.[3] The run usually lasts through the month of April. In 1979, it started during the last week of March.[4]

The success of smelt spawning depends upon stream flow and related depths. Flows in this reach of the stream are now very sensitive to precipitation because there is little water storage left in this urban watershed. As a result the flow rates are highly variable.

Proposed widening of the channel to 20 feet and changing its slope will reduce the water depth when the same flow is compared without and with the project. This reduction of water depth will inhibit smelt spawning. The relationship between flows and depth with the wider channel should be evaluated and the design modified if necessary to maintain adequate water depth. One possible measure would be to construct a pilot channel designed to have at least six inches of water at the normal flow rate during the spawning period. The low flow pilot channel should have vertical sides to reduce egg loss if the water level decreases. Another possible measure would be to maintain flows by releasing water stored in the Old Quincy Reservoir. If maintenance of water depth comparable to existing depth is not possible, the channel should not be widened.

There is a need to increase smelt spawning area and this could be accomplished by increasing the area of gravel on the stream bed. Placing gravel through the reach to be rechanneled should improve spawning and hatching. There are some short sections of this reach that have a sandy stream bed which is not attractive for spawning.

The smelt run at this location is a remnant of past runs. It is remarkable that it has persisted in the face of urbanization of the watershed. The drastic modifications of flow, discharge of pollutants from the streets, commercial and industrial concerns, and enclosure of the lower part of the stream in stone-lined banks, would be expected to eliminate the run. There is sufficient spawning success in Town Brook to maintain this run. It continues to make its contribution to the resources of the Bay where smelt are taken as a sport fishery, as well as serving as food for predator fish.

The outlet of the 12-foot diameter diversion tunnel will be located at the upstream end of a six-acre tidal wetland (see D, attached map) located between the Southern Artery and Elm Street. The wetland is about 2,000 feet long and is relatively narrow. It is surrounded by busy streets, commercial buildings and a school yard, and has relatively low wildlife value as a result. However, a few waterfowl, shorebirds and songbirds use the area. It has a variety of vegetation types associated with salt marshes that are unique to the watershed.

Widening of the natural channel from about 25 feet to 60 feet will remove about two acres of saltmarsh vegetation including most of the

[3]Ibid.

[4]MA Division of Marine Fisheries. Personal communication.

Spartina alterniflora. This is in addition to any loss resulting from the construction of the tunnel outlet structure in the upper end of the marsh. This saltmarsh is an asset for the surrounding area and should not be further degraded by the proposed construction. While it is not large enough to be highly significant for production of fish and wildlife resources, it is a small natural area in the midst of residences, commercial establishments, streets and a highway.

We understand that the tunnel will divert floods in excess of 200 cfs about 12 times each year. When these floodwaters start to flow through the tunnel, a flush of standing water in the tunnel will spread out over the wetland area. This water may be low in dissolved oxygen and could contain significant amounts of pollutants, such as petroleum products from garages and runoff from streets and highways, if seepage of underground aquifers is not sufficient to dilute pollutants and supply dissolved oxygen. The tunnel outlet should be placed where receiving waters can handle the flood surges and possible pollutants without the need for channeling in wetlands.

Anadromous fishes, such as the smelt, are attracted by the flow of water. They will usually try to follow the strongest flow whether it is coming down the stream or from the mouth of a tunnel. If a diversion of floodwater happened to occur during the smelt run, large numbers could be trapped in the tunnel. A barrier consisting of a spillway at least 24 inches high will be needed to prevent entrance of smelt or other species.

The loss of part of this wetland through channelization and construction of the tunnel outlet and temporary adverse impacts while the tunnel is in use can be avoided. Extension of the tunnel into Town River Bay should be considered.

Additional information will be needed on potential water elevations for the overflow outlet in Area B and potentials for storing water in the Old Quincy Reservoir to maintain the smelt area.

Please advise us of any steps you may be considering to minimize the adverse impacts of polluted water which will be discharged from the tunnel outlet.

If there are any changes in project plans, and if you have any questions concerning this letter, please let us know.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

Attachment

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. Box 1518
Concord, New Hampshire 03301

MAY 3 0 1980

Colonel William E. Hodgson
Deputy Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Hodgson:

This is our fish and wildlife report on plans being considered for flood protection in the Town Brook Watershed, Quincy, Massachusetts. Our planning aid letter of April 27, 1979, described the resources of the area and expressed our concerns about adverse impacts of plans then being considered.

A revised plan was described to us on May 16 and 20, 1980, by Mr. Adler and we have received a draft copy. The revised plan essentially eliminates our concerns about adverse impacts.

We were concerned about habitat destruction that would be caused by the proposed channel through the wetland upstream from the Granite Branch Railroad. The revised plan will cause no adverse impacts on this wetland. We recommend that you encourage permanent preservation of this site as a condition of the project. This site has open space value in this intensively developed community and has value for retarding flood water from sudden storms.

The channel widening that was planned for the reach between River Road and Bigelow Street has been dropped. Instead, a bypass conduit will be constructed along Miller Stile Road and Bigelow Street to bypass flood flows. It is critical that natural flows pass through the smelt spawning area during the spawning period. At the same time, smelt should not be allowed to get into the bypass conduit because they would then reenter the stream above the spawning area. This new plan will eliminate possible adverse impacts that could have been caused by widening the channel as originally planned. The large tunnel (12-foot diameter) that will be constructed to bypass flood flows from School Street to tidewater should not cause adverse impacts to fish and wildlife resources if normal flows (including spring freshets) are allowed to flow through the downstream end of Town Brook for smelt spawning. We understand that floodwater will not be diverted until the flow reaches 200 cfs, which

should be adequate. We also understand that the City of Quincy has requested the 25,000 cubic yards of rock that will result from tunnel construction. We do not know the intended use for this rock but the City should be aware of regulations concerning fill at environmentally sensitive sites.

The new plan to locate the tunnel outlet on upland about 900 feet downstream from the original location will eliminate the need to channelize the saltmarsh. Your plan to take flood easements on the tidal area will assure permanent preservation of this marsh. This change of plan will preserve the marsh in contrast to the original plan that would have destroyed part of the marsh.

Existing culverts under the southern artery will be enlarged to handle the flood flows. A section of the left bank downstream from the artery will be cut back to widen the channel. These proposals will have insignificant effects upon fish and wildlife resources. We recommend that the bottoms of the stream and culverts be left with a natural rubble and gravel bed.

The flap gate that will be placed on the downstream end of the culverts should be designed and operated so as not to delay the smelt run. The smelt usually run at high tide so that the gates should be open during high tides.

The project now has an environmentally sound plan. We will, however, want to review the final plans, especially the tunnel outlet structure, to see if any changes might be needed to avoid entrance of anadromous fish. We appreciate your effort to include our recommendations into the plans for this project.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

PERTINENT NEWSCLIPS

PATRIOT LEDGER
QUINCY, MA.

NOV 19 1979 New England

Town Brook

What could be the final drive for a $30-million flood control project in Quincy needs and deserves support from beyond the neighborhoods involved.

Two city councilors are urging residents of flood-prone South and West Quincy to lobby Senators Edward Kennedy and Paul Tsongas for help

The councilors, Daniel Raymondi and James Sheets, point out that legislation for the Town Brook project has been approved by the U.S. House of Representatives through the efforts of U.S. Rep. Brian Donnelly, D-Dorchester. That measure now must be acted on by the U.S. Senate, and the next few weeks will be crucial, as the two city councilors note.

The project to control flooding along Town Brook has been eight years in the making, but it is threatened by a change in federal guidelines. Residents along Town Brook end up with several feet of water in their homes during heavy rains. But under the new guidelines, the flow in the brook might not be heavy enough to allow the Army Corps of Engineers to begin construction.

The Quincy City Council recently resolved to put pressure on Congress to save the project. The efforts by Councilors Sheets and Raymondi to launch a citizens campaign for the project also should help.

Pressure won't be needed to get Senators Kennedy and Tsongas working hard for the project. But broad public support might help the senators get the flood relief measure enacted and signed by President Carter.

A few years ago, when the South Quincy MBTA station was opposed by many South and West Quincy residents, its supporters responded that the transit project would speed flood control work. The transit project is now under construction, but the flood control work is in deep trouble.

It's time those who pushed for the transit station get strongly behind the drive for flood control. South Shore labor organizations, the business community, state legislators, public transportation advocates and environmentalists should get to work.

That coalition succeeded in making the transit project a reality, and should prove a powerful ally in South and West Quincy's fight for flood control.

Quincy flooding

Residents of South and West Quincy, after years of promises from all levels of government, have a right to expect relief from flooding problems.

Heavy rain last week, which once again flooded streets and basements along Town Brook, served as a reminder of just how long it is taking to turn those promises into reality. Worse, there's a chance that the most important part of the flood control project might not be built at all.

Massachusetts agencies—the MDC, the state DPW and the MBTA—are doing their part. But the U.S. Army Corps of Engineers will not know for at least another two weeks whether it can go forward with its share of the project.

The state DPW is building a big culvert across Route 3 to carry Town Brook after it leaves Braintree Dam. On the Quincy side of the highway, the MBTA is preparing culverts to handle overflow from the brook through the South Quincy transit station area.

The MDC has $5 million available to install overflow culverts from the MBTA station to School Street in Quincy Center. The MDC work will be part of the city's Burgin Parkway extension, scheduled to start in the spring.

The MDC is also drawing final plans for the flood control system for Town Brook all the way from Braintree Dam to Town River.

But the big catch is that without Corps of Engineers construction of a flood-control tunnel from Quincy Center to Town River, the state work upstream will be of only limited value.

Last year, just as the corps seemed to be getting the upper hand against red tape, the rules changed. There is now a serious question whether there is a sufficient volume of water in Town Brook to satisfy new regulations for a corps project.

Those regulations went into effect because of objections raised by President Carter and Congress about big corps projects, most of them in western states. Critics of those big projects considered them environmentally dangerous boondoggles.

It's appalling that a small, long-planned and clearly needed project in Quincy is threatened by the regulations, while some of the "boondoggles" have been exempted by Congress.

The regional office of the corps in Waltham has fought a good battle to keep the Town Brook project alive. Efforts have been made to "grandfather" it from the new regulations. And a worthwhile plan was developed to tunnel floodwaters from Furnace and Cunningham Brooks to Town Brook, which could get the volume of water there up to the required levels.

Maybe the regional office will save the project. But Quincy officials and the Massachusetts congressional delegation should be take the fight to Washington.

The flooding problem received considerable attention at the time South Quincy station was a controversial issue. Elected officials, union leaders, the business community and the U.S. Department of Transportation let residents know that transit construction would spur flood control work.

Now that the MBTA project is in full swing, it is time to see that those promises about flood control are kept.

Consultant tells residents: Spring 1983

Burgin extension target date

US

QUINCY — A city engineering consultant told about 150 citizens, businessmen and state and local politicans last night, that the Burgin Parkway extension should be completed by spring 1983.

H. William Moore said bids will be sought this spring for the project's first phase construction of a connector road from the Grossman's Star Market complex to the Parkingway and extension of the Burgin Parkway to this connector.

Bids will be sought next spring for the second phase, the extension of Burgin Parkway to Centre Street and a tie-in with Route 3.

The first phase should be completed in one year, the second in two years.

This news received overwhleming support from the audience attending last night's meeting, conducted by the state Department Of Public Works.

The DPW held the hearing to obtain local comment on the plan before finalizing project design.

The project will provide quick access to downtown Quincy from greater Boston highways. The lack of such access has prevented major new developments in Quincy's business district for over a decade.

H.W. Moore engineer Franklin Ching said, after the meeting that, the project would cost $4 to $5 million. But he said the federal government will pay 75 percent of the cost, the state will cover 25 percent.

A deep flood-control culvert will parallel the parkway extension and carry flood waters from South Quincy to a point behind the Turnstyle store. It will cost about $5 million.

However, the Army Corps of Engineers has not yet built the underground tunnel that would carry the flood waters out to sea. Residents are worried that without the tunnel, the culvert will increase local flooding. Funds for the tunnel project are tied-up in Congress.

DPW representatives assured residents the culvert would not increase flooding. But the representatives agreed the tunnel is necessary for final solution of the flooding problem.

City councilor James Sheets said Congress should be prodded to fund the tunnel project.

Four homes on Marsh Street will be demolished to make

Quincy

way for the Burgin Parkway extension. Six Penn Street businesses — Oranger Manufacturing, South Shore Tile, Chiminiello Oil, Venus Wafer, Robbie Fuel and Quincy Garden Center — will be affected by project landtaking.

Walter J. Hannon, former mayor and planning director, said the project will benefit not only the downtown but also the entire city.

Albert Conti, South Quincy Civic Association president, said the project is vitally needed, and state senator Michael Morrissey called it "the key to revitalizing downtown."

Other proponents included city councilors Stephen McGrath and Sheets; James Lydon, director of city planning and development; state senator Paul Harold and William O'Connell, Quincy historical society president.

Thomas DeCourcy of the DPW said his department would purchase the homes of displaced residents and help them find new homes. He also said the DPW will aid businesses affected by the project.

Questioned after the meeting, involved residents said the DPW terms seemed fair. Within a year, they will be informed their property is needed for the project. Their property will be assessed and the DPW will offer to buy it at that assessment. The offer, however, can be appealed for another assessment. A seller will receive his money within 60 days and have up to four months to vacate.

John Goddard of 16 Marsh Street, a city fireman, said his satisfaction with the DPW plan will depend on "how well they appraise my house." Charles Hooper of 27 Marsh Street, said he'd prefer to stay in his home. "I don't think they need to take homes, but how can you stand in the way of progress?"

Andrew Neary of 24 Marsh Street said he was worried about finding a good place to live and paying more taxes. "I don't know where I can live as cheap," he said.

BRAINTREE STAR
BRAINTREE, MA.
W. 11,200

SEP 1 1 1980

New
England
Newsclip

Flooding Solution For Town

A deep tunnel to divert flood flows on Town Brook in Quincy and Braintree is the key to a flood protection system offered for public comment by the U.S. Army Corps of Engineers. The entire proposal is designed to solve chronic flooding in Quincy's business center and residential areas as well as in the Town Brook watershed and the Lakeside Drive, Braintree area. It will be discussed at a public workshop in Quincy City Hall on September 18th at 7:30PM.

Comment is required, according to Colonel Max B. Scheider, head of the Corps' New England Division, because parts of the proposed project come within the jurisdiction of Section 404 of the Clean Water Act of 1977, which regulates the discharge of dredged of fill materials in waters of the United States.

The recommended plan includes the construction of a 12-foot diameter tunnel in rock, 130 feet underground to divert flows from Town Brook and from proposed relief drainage conduits along the proposed Burgin Parkway. The tunnel would be drilled some 4,000 feet to the lower reach of Town River adjacent to the Southern Artery to allow outflows into wetland areas. New culverts would be placed under the Southern Artery and an adjacent parking lot. Downstream of the Artery, the left bank of the river would be widened to increase channel capacity.

Modifications to the Old Quincy Reservoir dam would include a new spillway and outlet structure, the flattening of the downstream face of the dam, repair of the stone protection on the upstream face, and other work. Construction of a dike along the north shore of the reservoir would prevent flood overflows into Lakeside Drive, Braintree.

All of the planning is being closely coordinated between the Metropolitan District Commission, officials of the two communities and Army Engineers.

The proposed project is a part of the overall urban drainage improvement system for Braintree and Quincy and is being designed in conjunction with a highway and mass transit planning.

With the project completed and operating, a flood event of the magnitude of the August 1955 episode would be controlled. "If such a flood were to strike now," Colonel Scheider said, "without the project, losses along Town Brook would be some $12,500,000." Average annual losses in the downtown Quincy business area are estimated at $1.9 million. The current cost estimate of the Corps-proposed project is $18.6 million.

All agencies, groups and individuals known to have an interest or responsibility associated with the proposal have received notice of the workshop meeting and the 404 evaluation report.

Under Section 404 review procedures, anyone may request a hearing to consider the water quality aspects of the proposed plan. Such a request should be specific in content.

Comments may be sent to Colonel Scheider at the New England Division, U.S. Army Corps of Engineers, 424 Trapelo Road, Waltham, MA 02154 no later that September 29, 1980.

Town Brook project: 4 years away

US

QUINCY — It could take four years before the Army Corps of Engineers begins construction on the $18.6 million Town Brook flood control project.

Colonel William E. Hodgson Jr., deputy division engineer, said four years was an "optimistic estimate" since the corps' proposed project must await congressional approval.

Col. Hodgson explained during a public hearing at Quincy City Hall last night the project would reduce flooding in Quincy and Braintree.

Under the plan, the corps would construct a 150-foot underground tunnel to divert flood flows out of flood-prone areas, larger culverts under the Southern Artery and improvements at the Old Quincy Reservoir.

Col. Hodgson said the federal government would cover all construction costs and the community would be responsible for providing all lands and rights of way necessary for construction, in addition to maintaining and operating the works.

The project, in the planning stages since 1970, was abandoned in 1978 when a new set of water flow regulations made it ineligible for federal funding.

But the corps changed its mind and resumed the project last February.

Both residents and area businessmen testified at the hearing that they approved the corps' proposed plan.

Hugh MacFarlane, 59, of 100 Elm St., said flooding has caused extensive damage over the years to his backyard and cellar.

"I'll support anything that cuts down the flooding," he said. "I'd like to see the project completed sooner, but the federal government doesn't do anything fast."

Louis Grossman, treasurer of Grossman, Inc., said the flooding has severely affected his business and also creates a health hazard.

"This is an important project and should be moved forward," he added.

City Councilor Daniel Raymondi also expressed his support for the corps' He told Col. Hodgson both the city council and the Mayor feel the project is vital.

Col. Hodgson said the plan would be submitted Sept. 30 to the corps' Chief of Engineers and the Board of Engineers of Rivers and Harbors for approval before it would be presented to Congress.

Quincy Patriot Ledger
Quincy, MA
Sep 19 1980

PUBLIC REVIEW COMMENTS

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION ONE
100 Summer Street - Suite 1517
Boston, Massachusetts 02110

IN REPLY REFER TO:
HEV-MA

Flood Protection Project - Town Brook
Quincy and Braintree, Massachusetts

September 17, 1980

Division Engineer
New England Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

Members of our staff have reviewed the draft feasibility report for this project. This project appears to be one which is sorely needed in Quincy and Braintree to reduce recurring flood damage from Town Brook. According to Figure 9, the proposed relief tunnel will pass under ten streets but the report contained no discussion of the effects of construction on local traffic flow patterns. Such a discussion should be a part of the environmental assessment.

Thank you for the opportunity to review this document.

Sincerely yours,

N. J. Van Ness
Division Administrator

P Robinson

By: P. Robinson
Transportation Planner

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

COASTAL ZONE
MANAGEMENT

September 18, 1980

Colonel Max B. Scheider
U.S. ARMY CORPS OF ENGINEERS
New England Division
424 Trapelo Road
Waltham, Mass. 02154

Re: NEDPL-1 Consistency Determination and Supporting Information for Town Brook Local Protection Project, Quincy, Mass., July 29, 1980

Dear Colonel Scheider:

We have completed our review of your July 29, 1980 consistency determination for the preliminary Feasibility Study. We feel that the initial study provides documentation of the need for the project as well as a general discussion of the nature of the alternatives to the project which are adequate to allow us to concur with your consistency determination.

However, it is important to recognize that this is the first phase of the project study/approval process for the Town Brook Local Protection Project. Later phases in this process will develop specific project plans which include a detailed analysis of the coastal resources affected and the mitigation methods to be employed. This later phase will also require a consistency determination. Although it is not possible to develop an all-inclusive list of specific details that must be addressed in later phases, your July [illegible] 1980, determination provides an excellent, but perhaps not exhaust[illegible] including:

- Wetland purchases or easements will be used to retain wetland values in the vicinity of the Town Brook outlet structure (policy 1, p. 2). MCZM strongly supports these suggestions. In addition, wetland losses attributable to the outlet structure itself or to the effects of current scouring should be thoroughly studied and possible mitigation plans developed.

- Stream bypassing or work rescheduling will be studied to minimize the construction effects on smelt spawning (Policy 2, p. 2). We also support this effort and strongly suggest that the Corps enlist the assistance of the Massachusetts Division of Marine Fisheries in developing such plans.

- Anoxic waters may be released into Town Brook during initial tunnel flushing (Policy 2, p. 2). This potential problem should be studies very carefully and specific plans developed to compensate for or prevent any impacts, should the potential for damage appear to be high.

- Tidal flaps will be installed to maintain present tidal conditions and flushing characteristics (Policy 4, p. 3). Tidal flaps are notoriously unreliable and require frequent maintenance to perform even an irregular open-closed function. Further, the planned increases in conduit size at the mouth of Town Brook could, conceivably, improve water quality. The need for and method of control of tidal gates should be clearly established in later phases of the study. Also, substantiation that the project will not substantially impact on productive coastal wetlands (Policy 10, p. 3). We feel that the actual impacts due to filling and current induced erosion of wetlands should be documented in later phases. A detailed mitigation plan should be designed and costed out for <u>any</u> level of impact. An appropriate mitigation plan could then be selected should the impacts be interpreted as significant by MCZM.

We would again like to compliment you and your staff on your excellent job in preparing the detailed consistency determination and for coordinating this phased consistency review with MCZM. I am certain that your careful attention to our comments in this letter will help to make the final phase consistency review as expeditious and fruitful as this first phase has been. However, I hope that you will realize that our comments are not all-inclusive and trust that you will rely on open communications and honest interpretation of our policies should other issues surface.

We expect that a smoothly functioning phased consistency review process between the New England Division and MCZMP could serve as a model for coordination elsewhere and are very committed to it. In that vein, I hope that you will feel free to contact Michael Penney, of my staff, or myself should any problems or questions arise.

Sincerely,

Richard J. Delaney

Edward J. Reilly for EJR
Assistant Secretary

EJR/MEP:dc

cc: Rob Adler, Corps
Dick Foster, MEPA
Pat Corcoran, MDC

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. Box 1518
Concord, New Hampshire 03301

SEP 23 1980

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

Mr. Ignazio's letter of August 29, 1980, requested our review of the draft Feasibility Report for Water Resources Development, Town Brook, Quincy and Braintree, Massachusetts. We have reviewed the report and suggest that the following revisions be made:

The 8 to 10-acre freshwater wetland located between Route 3 and Centre Street in Quincy will not be altered by the project. However, we reiterate our recommendation (FWS report dated May 30, 1980) that action to preserve this wetland for wildlife habitat, open space value and flood retardation be included as a part of your plan. We appreciate that the recommended plan avoids channelizing this area which was proposed during earlier studies. Your action will eliminate adverse impacts from the project but will not assure future preservation. This could be accomplished by incorporating acquisition of the site as a natural valley storage site into your plan or by including its preservation as a part of the contribution by non-Federal interests. Item "e" of the Recommendations on the last page of the report could be interpreted as including preservation of this site, but it is not specific. Action to assure preservation of this wetland would be in accordance with the second planning objective stated at the top of page 18, and would contribute to the EQ and NED objectives of the project.

The last sentence in the paragraph referring to the upstream freshwater wetland on page 4 of the Environmental Assessment should be revised because it does not accurately reflect what we said in our letter of April 27, 1979. The statement that we made (paragraph 5, page 2) is "It is not a highly significant wildlife area on a broad scale, but the small mammals and songbirds that live there add to the human environment values of nearby residents." Ducks were seen in the area but we have not verified the extent of this use. It is possible that some nesting may occur.

Item "b" under "C.1" of the Summary Comparison of Final Alternative Plans mentions preservation of the smelt spawning area and the saltmarsh. Easements on the wetland (saltmarsh) are the only action mentioned under Plan A. Preservation of the smelt spawning area should also be included.

The third paragraph on page 8 and the first paragraph on page 55 under "Recommended Plan" describes the proposal to widen the channel through the 500-foot reach downstream from the Southern Artery. We received a report from the Massachusetts Division of Marine Fisheries that smelt may be spawning in this reach. This was received after we submitted our report of May 30, 1980, and needs to be documented. If spawning does take place at this site, we would recommend that coarse gravel be placed on the channel bed.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
BOSTON AREA OFFICE
BULFINCH BUILDING, 15 NEW CHARDON STREET
BOSTON, MASSACHUSETTS 02114

REGION I

IN REPLY REFER TO

Division Engineer
New England Division
U.S. Army Corps ot Engineers
424 Trapelo Road
Waltham, Mass. 02154

9/23/80

Re: Draft Feasibility Report
Town Brook Local Protection
Quincy and Braintree, Mass.

The Boston Area Office of HUD has reviewed the "Draft Feasibility Report" for providing flood control measures in the Town Brook for Qunicy and Braintree, Massachusetts.

The flood control measures proposed within the Town Brook area will not effect the plans and goals of this office in the area of housing.

Thank you for giving this office the opportunity to review and comment on the above proposal.

Sincerely

Edward Machado
Environmental Officier

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

September 29, 1980

Colonel Max B. Scheider, Division Engineer
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254

RE: Town Brook Local Protection
Quincy and Braintree, Massachusetts

Dear Colonel Scheider:

We have completed our review of the Draft Feasibility Report for Water Resources Development, and the Public Notice of Section 404 Evaluation/ Environmental Assessment for Town Brook Local Protection Project, Quincy and Braintree, Massachusetts. The 404 (b) evaluation review, performed by our Permits Branch has been incorporated in the following comments.

We believe that the Final Feasibility Report, Section 404 Evaluation, and Environmental Assessment could develop a more environmentally acceptable flood protection project by detailing specific actions of handling the stagnated stormwater, and by committing to the implementation of specific corrective measures.

We support the Corps decision to conduct detailed water quality studies to assess: the potential of anoxic waters in the proposed relief tunnel; the impact of a lower water quality on the chemical, physical, and biological integrity of the aquatic ecosystems; and means of mitigating potential water quality degradation. Should the water quality studies indicate potential impacts, all possible contingency measures and combination of measures should be identified and evaluated.

Thank you for the opportunity to comment on the draft reports and we look forward to receiving the final. Please send two (2) copies of the final reports when they become available.

If you have any questions, please feel free to contact Donald Cooke on my staff at (617) 223-4635.

Sincerely,

Richard R. Keppler

Richard R. Keppler, Acting Director
Environmental & Economic Impact Office

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Environmental & Technical Services Division
Environmental Assessment Branch
7 Pleasant Street
Gloucester, Massachusetts 01930

NOV 5 1980

Col. William E. Hodgson, Jr.
Acting Division Engineer
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Hodgson:

This is in reference to Mr. Ignazio's letter of August 29, 1980, concerning the draft feasibility report and Section 404 evaluation for the proposed local flood protection project on Town Brook in Quincy and Braintree, Massachusetts.

We have reviewed the report and concur in its finding. As a result of this we have no objection to project implementation. We wish to commend the efforts your agency has taken to protect fisheries resources and associated habitats. As stated on pages 17 and 18, two of the three Planning Objectives listed are to protect rainbow smelt spawning areas in the lower reaches of Town Brook and to protect wetlands. Further, although it is not stated specifically (item e on the last page of the report), it is our understanding that easement will be acquired on wetlands to prevent encroachment and to preserve the area as a natural valley storage site.

On page 55, first paragraph, the recommended plan describes a proposal to widen the channel downstream from the Southern Artery. A personal communication with a staff member from the State of Massachusetts, Division of Marine Fisheries, indicated that smelt may be spawning in this area. If spawning does occur in this area we recommend that the proposed channel bottom be constructed of coarse gravel. This type of substrate is necessary for the development of smelt eggs.

Sincerely,

Ruth Rehfus

Ruth Rehfus
Acting Branch Chief

NERBC

New England
River Basins Commission

141 Milk Street, Third Floor
Boston, Massachusetts 02109
Tel. 617-223-6244

30 September 1980

Mr. Joseph L. Ignazio, Chief
Planning Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Mr. Ignazio:

We have reviewed the September 1980 Section 404 Evaluation/ Environmental Assessment for the Town Brook Local Protection Project in Quincy and Braintree, Massachusetts. The assessment is responsive to the recommendation in the Report of the Southeastern New England Study requesting a study of the flooding problems in Braintree, MA. (SENE, 2. Boston Metropolitan Planning Area Report, p.8-5, Recommendation 3.) In addition, the assessment appears to be consistent with NERBC's Regional Policy Statement on Flood Plain Management in New England in that it has taken nonstructural management approaches into consideration for flood damage reduction.

Thank you for the opportunity to comment on the draft plan.

Sincerely,

Bob

Robert D. Brown
Director of Plan
Utilization

RDB/jh

cc. John Bewick, Secretary of Environmental Affairs, MA
Elizabeth Kline, EOEA, MA

The Commonwealth of Massachusetts

Executive Office of Environmental Affairs
Department of Environmental Management
Division of Water Resources
Leverett Saltonstall Building, Government Center
100 Cambridge Street, Boston 02202

OFFICE OF THE DIRECTOR

September 16, 1980

Colonel Max B. Scheider, Division Engineer
U.S. Army Corps of Engineer
424 Trapelo Road
Waltham, Ma. 02154

Dear Colonel Scheider:

We have reviewed your Town Brook Local Protection Feasibility Report.

This is to say that it appears to offer an excellent treatment of a complex urban flooding problem.

Sincerely yours,

Charles F. Kennedy

Charles F. Kennedy
Director & Chief Engineer

CFK/WFB/ha

COMMENTS AND RESPONSE

(Based on comments received from public review of Draft Feasibility Report, which included the Environmental Assessment and Section 404 Evaluation)

FEDERAL

U.S. Fish and Wildlife Service

Comment 1: The Service recommends that the proposed plan should include preservation of the 8 to 10-acre freshwater wetland located between Route 3 and Centre Street in Quincy, even though the wetland would not be affected by the project.

Response: Since the wetland would not be affected by the project, nor would it offer sufficient flood retention to benefit the project proposed further downstream, it would not be appropriate to include its future preservation in the plan. The Corps believes that such action would constitute a mitigation of no impact. However, we will continue to advise local interests of the benefits they would receive by preserving this wetland. In addition, any efforts to alter these wetlands would be subject to local, State and Federal regulatory review.

Comment 2: A statement in the Environmental Assessment on the upstream freshwater wetland did not accurately reflect the Service's previous coordination as to the value of the wildlife in the wetland to nearby residents.

Response: The Assessment, has been modified in accordance with the comment. The statement has been changed to read that the upstream wetland "is not a highly significant wildlife area on a broad scale, but the small mammals and songbirds that live there add to the human environment values of nearby residents."

Comments 3 and 4: The Service suggested that the Summary Comparison of Final Alternative Plans should include preservation of smelt spawning areas. Comment 4 refers to a report from the Massachusetts Division of Marine Fisheries (DMF) indicating that smelt may be spawning in the tidal area below the Southern Artery. If this is accurate, the Service recommends placing gravel in the excavated area to improve spawning beds.

Response: The known smelt spawning areas are between Revere Road and Elm Street. This is upstream of the Town River wetland where the tunnel waters would exit the outlet shaft. As a result, the project will not affect the known smelt spawning areas of the brook upstream of Elm Street. Please refer to our response to Comment 1, where we address the issue of preserving areas that would not be affected by the project.

We are not aware that smelt spawn in the areas of the brook below Elm Street. We thank the Service for informing us about the Massachusetts DMF report indicating that the tidal areas, particularly below the Southern Artery, may be spawning areas. We will seek additional information and coordination to determine whether the coastal area of Town Brook provides spawning potential as the comment indicates. If spawning does occur below the Southern Artery we will consider placing gravel on the channel bottom to enhance spawning bed characteristics.

U.S. Department of Transporation

Comment 1: The proposed relief tunnel will pass under ten streets but the report contained no discussion of the effects of construction on local traffic flow patterns.

Response: The proposed relief tunnel would be constructed approximately 190 feet below ground level. The tunnel construction would have no affect on the streets above it. Construction of the inlet and outlet shafts would be located in vacant areas and would not directly affect local streets.

Environmental Protection Agency

Comment 1: The final project reports could develop a more environmentally acceptable project by detailing corrective measures to handle stagnating storm waters. EPA supports the further investigation into the potential of tunnel waters becoming anoxic, the effects of degraded water quality on the aquatic ecosystem, and means of mitigating potential problems.

Response: The Corps will investigate the potential of storm waters becoming anoxic while in the tunnel for prolonged periods. Since there is a potential water quality problem, the Final Feasibility Report presents a mitigating measure as a contingency solution. It was developed for a worst case

conditions where all tunnel waters would be exchanged with fresher tidal water to eliminate potential stagnation. This mitigation measure is presented in the report and described in more detail in Chapter 2 of Appendix D, Final Feasibility Report.

U.S. Department of Commerce, National Marine Fisheries Service

Comment 1: The Service has no objection to the project since efforts were made to provide protection for the fisheries resource and associated habitats.

Response: None necessary. Thank you for your review and comment.

Comment 2: The Service indicated that the report may have left some uncertainty around the issue of purchasing or acquiring easements on the wetland for its protection.

Response: For clarification, one element of the project will be to acquire or obtain easements on the wetland to maintain its existence.

Comment 3: It was recommended that a gravel substrate be placed for smelt spawning in the area proposed for widening downstream of the Southern Artery, if smelt spawning does occur there.

Response: Please see the response to the U.S. Fish and Wildlife Service comments 3 and 4.

Department of Housing and Urban Development (HUD)

Comment 1: The proposed flood control project will not affect any HUD plans or goals.

Response: None necessary. Thank you for your review and comment.

REGIONAL

New England River Basins Commission (NERBC)

Comment 1: The Town Brook study is responsive to the recommendation in the SENE report requesting an investigation of the flooding problems in Braintree, Massachusetts. The assessment appears consistent with NERBC's policy for flood plain management.

Response: None necessary. Thank you for your review and comment.

STATE

Executive Office of Environmental Affairs, CZM Office, Massachusetts

Comment 1: The Massachusetts Coastal Zone Management (MCZM) Office concurs with the Corps initial consistency determination based on the need for a project and the alternatives to it. A final consistency determination would be required in the next phase when mitigation measures have been studied and detailed plans have been developed.

Response: A final determination would be submitted to the MCZM Office for final concurrence in the next phase. That determination will address the additional information requested in the comments below.

Comment 2: MCZM Office supports the Corps plan for purchasing or obtaining easements to retain the Town River wetland. A recommendation was made to study and mitigate the wetland losses from the construction of the outlet structure and from effects of scouring from tunnel discharges.

Response: Approximately 1/2 acre of wetland may be temporarily altered or eliminated with construction of the outlet feature. This plan has already been developed to minimize the wetland impacts of previous alternatives. However, during the design phase of the project, construction details would be considered further to minimize wetland impacts to the maximum extent practicable. This would include design review of the discharge features and energy dissipators to mitigate potential scouring from tunnel discharges at low tides.

Comment 3: MCZM Office supports stream bypassing or work rescheduling to minimize possible construction effects on smelt spawning. It was suggested that the Corps contact Massachusetts DMF to aid in developing plans to minimize construction effects on smelt.

Response: Features to minimize construction effects on smelt spawning would be included in plans and specifications for the project. The DMF would be contacted for their coordination.

Comment 4: Anoxic waters released from the tunnel may be a potential problem. Studies should be made to ascertain if a problem could develop and appropriate mitigations should be included in the project.

Response: Studies will be made to determine if tunnel waters would stagnate and become anoxic. However, as a precaution against that possibility a mitigating feature was developed to exchange waters in the tunnel. The flushing action was designed for the worst case condition where all tunnel waters become anoxic. An explanation of this feature is presented in Chapter 2 of Appendix D, Feasibility Report.

Comment 5: Tidal flaps are unreliable and require frequent maintenance. The need for such gates should be clearly established in the next phase. Impacts of filling and current induced erosion should be documented and appropriate mitigation should be included. MCZM Office would review the impacts and any proposed mitigation plans.

Response: The use of tidal flaps would be reviewed, however, at this stage they appear necessary. The added culvert size would allow increased tidal action upstream of the Southern Artery with the potential for causing increased flooding that does not exist in this reach. Construction impacts to the wetland from fill activities for the outlet structure, and impacts from erosion from tunnel discharges, will be reviewed during project design (see response to comment 2).

The final review of the effects of the project on the wetland from filling activities and potential scouring will be presented to the MCZM Office in our second phase Consistency Determination. Continued coordination with the MCMZ Office will be maintained.

Department of Environmental Management, Massachusetts

Comment 1: The Town Brook Feasibility Report appears to offer an excellent treatment of a complex urban flooding problem.

Response: None necessary. Thank you for your review and comment.

Appendix D

Hydrology and Hydraulics

TOWN BROOK
QUINCY, MASSACHUSETTS

APPENDIX D

CHAPTER I

HYDROLOGIC ANALYSIS OF FLOODS AND IMPROVEMENTS

BY
HYDROLOGIC ENGINEERING SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

JUNE 1980

CHAPTER I

HYDROLOGIC ANALYSIS OF FLOODS AND IMPROVEMENTS TOWN BROOK QUINCY, MASSACHUSETTS

TABLE OF CONTENTS

Paragraph	Subject	Page
1	PURPOSE	1
2	PROCEDURE	1
3	WATERSHED DESCRIPTION	1
4	DISCHARGE RECORDS	3
5	STAGE-DISCHARGE RATINGS	3
6	STORAGE CAPACITIES	5
7	UNIT HYDROGRAPHS	6
8	STORM RAINFALLS	6
9	ANALYSIS OF FLOODS	6
10	EFFECTS OF IMPROVEMENTS	9
11	FLOOD FREQUENCIES	12
12	TIDE LEVELS	12
13	STANDARD PROJECT FLOOD	13
14	PROJECT DESIGN FLOOD	14
15	SELECTED TUNNEL DESIGN	15
16	RESERVOIR IMPROVEMENTS	16

LIST OF TABLES

Table	Title	Page
I	Town Brook Gage - Peak Annual Stages and Flows	4
II	Unit Hydrograph Pertinent Data	7
III	Storm Rainfalls	8
IV	Comparative Flood Data	10
V	Effects of Initial Storage at Old Quincy Reservoir	11
VI	Pertinent Tide Data	12
VIII	Standard Project Flood	14

LIST OF PLATES

Plate	Title
1	Watershed Map
2	Discharge Rating Curves
3	Storage Capacity Curves
4	January 1979 Flood Analysis
5	Storm Runoff Comparisons
6	March 1968 Flood Analysis
7	August 1955 Flood Analysis
8	Dishcarge and Stage Frequency Curves
9	Plan and Profile #1
10	Plan and Profile #2
11	Spillway Design
12	Standard Project Flood Plan and Profile #1
13	Standard Project Flood Plan and Profile #2

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TOWN BROOK LOCAL PROTECTION, MASSACHUSETTS COASTAL STREAMS: FEA--ETC(U)

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APPENDIX D
CHAPTER I

TOWN BROOK
QUINCY, MASSACHUSETTS
HYDROLOGIC ANALYSIS OF FLOODS AND IMPROVEMENTS

1. PURPOSE

This chapter of Appendix D presents data, analysis and discussion of the flood hydrology for Town Brook in Quincy, Massachusetts. Studies included the development of an HEC-1 computer model using information from previous studies plus 7 years of stream flow records. The model was then used to access the development of floods on the brook, the frequency and magnitude of flood events, and the effects of pending and proposed channel modifications. Hydrologic features of planned improvements plus hydrologic design criteria are also presented in this Appendix.

2. PROCEDURE

The study procedure for the hydrologic analysis of floods was as follows:

a. The watershed was divided into subareas. Stage-storage, stage-discharge and unit hydrographs were developed and inputted into the HEC-1 computer model.

b. The model was calibrated by analyzing and reproducing selected rainfall-runoff events recorded during the short term 7-year gage record.

c. Once the model was calibrated, a series of flood events was modeled applying both historic and synthetic storm rainfall. This information was then used to derive flood magnitude and frequency information.

d. The hydrologic effects of pending and proposed modifications to the channel were then analyzed by making appropriate changes in the stage-discharge relations in the model and rerunning a selected flood series.

3. WATERSHED DESCRIPTION

Town Brook has a total watershed area, above tidewater, of approximately 4.5 square miles. The brook originates at Old Quincy Reservoir in Braintree, a reservoir built in the 1880's as a water supply for Quincy but now used only as a source of industrial supply. This reservoir has about 1.5 square miles of relatively flat, quite highly developed watershed. Though it was noted by the original designers of the reservoir that the watershed was 1,000 acres of poor land not suitable for cultivation and would not ever be developed, the area is now criss-crossed by expressways and contains a shopping center, plus other extensive commercial and residential develop-

ment. Presently, efforts are being made to maintain the reservoir 6 to 8 feet below spillway crest to provide runoff storage for reducing downstream flooding.

Downstream of the reservoir, the stream flows easterly through a residential section of Braintree, beneath the Route 3 expressway and into the Centre Street flood plain area of Quincy. The intervening area between the reservoir and Centre Street is 1.4 square miles made up of rolling, moderately developed area comprised of single family residences, industries, highways and old stone quarries.

From the Centre Street flood plain area, the brook continues to flow easterly at an extremely flat gradient along Brook Street to School Street. The brook is mostly underground in this reach either in concrete conduit or capped granite walled rectangular channel. This reach, with an intervening drainage area of about 0.8 square miles, has a long history of flooding. Development in the flood plain in the past was mostly the stone quarry-related industry and older residences of Quincy. However, the advent of expressways and the extension of a rapid transit line through the area has brought accelerated development pressures for large apartment complexes, schools, and added commercial development.

From just downstream of School Street, the stream is conveyed underground through the center of the city of Quincy, one of the oldest cities in the United States, the home of the Hancocks and Adamses, and the birthplace of two U.S. Presidents.

The intervening drainage area of the stream in central Quincy is about 0.7 square miles of highly developed urban area and the brook enters tidewater near Washington Street where the total drainage area is a little over 4.5 square miles.

A watershed map of Town Brook is shown on plate 1. Plans and profiles of the brook from the vicinity of Centre Street to Washington Street are shown on plates 9 and 10. For purposes of hydrologic analysis, the watershed was divided into the following subareas:

Subarea	Drainage Area (sq. mi.)	Accumulative
Old Quincy Reservoir	1.56	1.56
Local to Centre St. Storage	1.42	2.98
Local to Brook Rd. Storage	0.79	3.77
Local to Upper Reach of Quincy Conduit	0.27	4.04
Local to Bigelow Gage	0.42	4.46

Modifications to the brook channel consist of a planned auxiliary conduit, by others, extending from near Centre Street to downstream of School Street, and a proposed Corps of Engineers tunnel extending from the auxiliary conduit outlet, beneath Quincy to Town River Bay. The approximate alignment of these improvements is shown on Plates 1, 9 and 10.

4. DISCHARGE RECORDS

There are no long term discharge records for Town Brook. However, as part of ongoing flood studies, the U.S. Geological Survey, at the request of the Corps of Engineers, installed a stage recorder on Town Brook in September 1972. This station is located near Bigelow Street (drainage area 4.46 sq. mi.) a short distance upstream from where the stream enters tidewater at Washington Street. The station has been in continuous operation since September 1972, thus providing 7 years of stream records. These records, though of relatively short duration, proved useful in the development and calibration of the HEC-1 computer model. Peak stages and discharges recorded at this gage are summarized in Table I.

5. STAGE-DISCHARGE RATINGS

Stage discharge relationships were developed for Old Quincy Reservoir and at selected index stations along Town Brook. The discharge rating at Old Quincy Reservoir was developed for the existing 25-foot long overflow spillway at elevation 80.9 NGVD and for an overbank flow area with an assumed length of 50 feet and at an approximate elevation of 83 feet msl. Capacities were computed using the conventional weir formula with "C" values of 3.2 and 2.6 for the spillway and overflow area, respectively.

Stage-discharge rating curves were developed for selected index stations along the brook using available cross-sectional information and stream gradients. Capacities were computed by Manning's equation using "N" values ranging from 0.015 for smooth concrete to 0.030 for rock channel and overland flow. Key index stations for the study were:

Index #2	-	Bigelow Street Gage Rating
Index #2A	-	Quincy Conduit Rating
Index #3	-	Brook Road Conduit Rating
Index #4	-	Centre Street Storage Outflow Conduit Rating

Stage-discharge relations were developed assuming normal flow through the immediate reaches and then were later adjusted as necessary to reflect the effect, under certain flood conditions, of significant downstream backwater. Both Brook Road and Centre Street stages were in many cases a function of downstream backwater. The adopted normal flow rating curves, both for existing and modified channel conditions, are shown on plate 2.

TABLE I

TOWN BROOK GAGE
PEAK ANNUAL STAGES AND COMPARATIVE FLOWS

Date	Peak Stage (ft)	"Q" USGS Rating (cfs)	"Q" Corps Rating (cfs)
August 1973	6.83	378	335
August 1974	6.79	372	330
May 1975	7.44	481	385
August 1976	7.08	442	365
August 1977	5.34	268	268
January 1978	5.62	289	285
January 1979	6.93	430	360

Datum of Gage = Approximately 5 feet NGVD

The stage-discharge curve developed at Bigelow Street deviates somewhat from that adopted by the USGS. The USGS rating was based on measured flows up to 300 cfs and the upper range of the curve defined by log-log extension. The curve computed in the current study agreed with the USGS curve in the lower range but indicated less capacity in the upper range due to the restrictive downstream conduit. Both the USGS ratings curve and that computed and adopted in the current study are shown on Plate 2. Peak annual stages at Bigelow Street and the corresponding peak discharges using both ratings are comparatively listed in Table 1.

The rating curve at Centre Street, for improved conditions, was based on an 8 x 10 foot conduit to be installed by others, with an invert at elevation 18 feet msl and an energy gradient of 0.001 ft/ft. Adjustments were then made in this rating as necessary to reflect downstream backwater effects. Stage-discharge ratings at the proposed tunnel entrance below School Street, for various tunnel plans, were developed assuming the tunnel inlet would be designed to provide ample capacity to the tunnel allowing either the tunnel or the upstream improved channels to become the hydraulic control rather than the inlet structure. It was further assumed that, if a diversion tunnel was built, residual floodflows allowed to enter the existing Quincy conduit would be restricted to about 100 cfs, thereby increasing flood control benefits downstream. The actual inlet design and allowable downstream flow would be refined in any final design and would likely vary somewhat from the assumed conditions, but it was believed that the above assumptions provided information adequate for the hydrological assessment of the flood control potential of the various plans of improvement. A tunnel inlet design for the finally selected tunnel plan is discussed in Section 19 of this Appendix.

Capacities for various sized deep rock tunnels beneath Quincy were based on a length of 3,800 feet, a Manning's "N" of 0.015, an entrance "K" of 0.5, an exit "K" of 1.0 and a design tailwater level of 7 feet NGVD.

6. STORAGE CAPACITIES

Three principal flood storage areas in the watershed were analyzed using the "modified puls" method of storage routing. The three storage areas were: Old Quincy Reservoir, Centre Street and Brook Road. Though other areas along Town Brook experience flooding, the volume of flood plain storage in these areas is not sufficiently large to significantly affect flood hydrograph peaks. The storage capacities for the three principal storage areas were determined by planimetering topographic maps of the areas and from information developed by Metcalf & Eddy, Inc. Engineers in earlier ongoing studies of the brook. Storage capacity curves for the three areas are shown on Plate 3.

All routings were made with Old Quincy Reservoir initially at elevation 73.4 feet NGVD, 7.5 feet below spillway crest. This is the average or normal level of the reservoir under present operation, though it often fills above this level during freshets. Two comparative flood routings were also made with the reservoir assumed initially full. This data is summarized in Table V.

7. UNIT HYDROGRAPHS

Flood hydrographs for the different subareas were computed by applying storm rainfall to adopted unit hydrographs. Unit hydrographs were developed for each subarea using varying "Snyder's coefficients" based on watershed characteristics. The coefficients were then refined in the process of calibrating the HEC-1 computer model. The watershed characteristics and finally adopted coefficients are listed in Table II.

8. STORM RAINFALLS

The greatest flood producing storm rainfall of record in the Quincy area occurred in August 1955 as a result of rainfall associated with Hurricane "Diane". This storm produced about 5.3 inches of rainfall in a 6-hour period and, though the upper watershed was much less developed than today, the resulting flood in Quincy was believed to be the greatest in that city's history.

The second greatest flood producing rainfall of record, and the most recent, occurred in March 1968. This storm produced a maximum 6-hour rainfall of only 2.5 inches but the 18-hour total was about 5.7 inches. This storm occurred at a time of very high antecedent conditions, greatly aggravating the resulting flooding which in many areas along Town Brook was nearly equal to that of 1955.

Two other notable storm rainfall events of record in Quincy, which were associated with hurricanes or coastal storms, occurred in September 1954 and September 1961. Fortunately, these storms occurred at times of lower antecedent conditions than those of the 1955 and 1968 flood events.

Maximum short duration storm rainfalls, experienced since 1972 when stream records became available, occurred in August 1973 and 1974, May 1975 and January 1979. The maximum 1-hour and 6-hour rainfalls for these recent storms as well as the historic events and synthetic 100-year and 10-year rainfalls, as determined from U.S. Weather Bureau T.P. #40, are listed in table III. Rainfall-time distribution for the August 1955, March 1968 and January 1979 storms are graphically illustrated on plates 4, 6 and 7.

9. ANALYSIS OF FLOODS

A series of storm rainfall events, that occurred during the period of stream record since 1972, were analyzed in the development and calibration of the HEC-1 computer model. In calibrating the model, it was found necessary to increase initial estimates of Snyder's "Tp" to establish reasonable agreement in timing between rainfall and runoff. These increased "Tp's" resulted in somewhat lower unit graph peaks than were initially estimated. The component development of the January 1979 storm runoff, using the finally calibrated model, is graphically illustrated on plate 4. Comparisons of model computed and observed data for the storms of January 1979, August

TABLE II

UNIT HYDROGRAPH PERTINENT DATA

Subarea	Area (sq.mi.)	"L" (ft)	Slope (ft/ft)	"Synder's"		"Clark's"	
				Tp	Cp	Tc	R
Old Quincy Reservoir	1.56	10,000	.017	2.5	0.50	10.6	13.6
Local to Centre Street Storage	1.42	6,000	.020	2.0	0.55	8.8	9.3
Local to Brook Road Storage	0.79	4,000	.015	1.5	0.55	6.8	6.8
Local to Upper Reach of Quincy Conduit	0.27	2,000	.030	1.0	0.60	4.7	3.7
Local to Bigelow Gage	0.42	2,000	.010	1.0	0.60	4.7	3.7

TABLE III

STORM RAINFALLS

Storm	1 Hour Maximum (inches)	6 Hour Maximum (inches)
August 11, 1973	0.74	1.3
August 29, 1974	1.53	1.9
May 13, 1975	1.24	1.6
January 21, 1979	0.36	1.7
September 11, 1954	0.95	4.2
August 19, 1955	1.74	5.3
September 21, 1961	0.88	2.3
March 18, 1968	0.50	2.5 (18 hr. = 5.7")
100 year	2.6	4.8
10 year	1.8	3.4

1973 and May 1975 are graphically illustrated on plate 5. The deviation between computed and measured flow on the recession side of the August 1973 and May 1975 hydrographs is attributed to flows entering flood plain areas, being partially absorbed, and not readily returned to the stream as was the case in January 1979, when flood plain soils were frozen or nearly saturated from earlier rainfall and/or snowmelt.

Once the model was calibrated, through analysis of the recent storm events, it was used to develop and analyze both historic and synthetic 100 and 10-year flood runoff. The component development of the recurring August 1955 and March 1968 floods is graphically illustrated on plates 6 and 7. Comparative data for a series of floods is listed in table IV.

10. EFFECTS OF IMPROVEMENTS

Lastly, planned and proposed improvements of Town Brook were hydrologically analyzed by adjusting stage-discharge relations in the model to reflect such improvements. The improvements considered consisted of an auxiliary channel, by others, between index 4 and 2A, and a proposed tunnel from index 2A beneath downtown Quincy to tidewater in Town River.

Analyses consisted of adjusting the stage-discharge relations in the model to reflect the hydraulic changes and then rerunning a selected flood series. Studies were made for conditions with upstream improvements alone, i.e., auxiliary conduit, and with upstream improvements plus installed Quincy tunnel. The selected floods are shown on Plan anf Profile sheets on Plates 9, 10, 12, and 13.

Computed discharges and stages for a series of floods are listed in table IV for three conditions: (1) existing conditions, (2) upstream improvements by others between index 2A and 4 with no tunnel, and (3) upstream improvements plus a 12-foot Quincy tunnel.

The hydrologic effect of the channel improvements, in general, is to reduce flood plain storage and increase peak flood discharges. It is noted, however, that the effect of the planned upstream improvements, alone without the tunnel, is to release more flows from the Centre Street storage into the Brook Road storage. This would reduce flooding in the Centre Street area but could increase downstream flooding unless increased discharge capacity is provided downstream. This is demonstrated by the comparative March 1968 flood profiles shown on plates 9 and 10.

Table V is also provided to demonstrate the effect if Quincy Reservoir were assumed initially filled to spillway crest. The demonstration floods, the March 1968 and 10-year synthetic, are considered representative of moderate range floods, one being of a short duration high intensity type and the other a longer duration higher volume flood.

TABLE IV

COMPARATIVE FLOOD DATA

	Quincy Reservoir			Centre Street (Index #4)			Brook Road (Index #3)	M.T.A. Line (Index #2A)			Bigelow Street (Index #2)	
	Inflow (cfs)	Outflow (cfs)	Stage (msl)	Inflow	Outflow	Stage	Stage	Inflow	Outflow	Stage	Outflow	Stage
MARCH 1968 FLOOD ANALYSIS — RAINFALL EXCESS = 4.6 INCHES IN 18 HOURS												
Existing Conditions	356	150	82.5	355	180	33	27.6	430	330	24	425	13.2
With Upstream Improvements	356	150	82.5	355	-	29	28.9	635	470	28.7	530	15.1
Upstream Imp. + 12 Ft. Tunnel	356	150	82.5	355	355	24	22.5	635	630	21.5	220	9.7
AUGUST 1955 FLOOD ANALYSIS — RAINFALL EXCESS = 5.0 INCHES IN 7 HOURS												
Existing Conditions	745	200	83	835	357	33.8	29.5	900	450	28.4	720	16.2
With Upstream Improvements	745	200	83	835	-	31.3	31.0	1300	760	30.8	870	16.8
Upstream Imp. + 12 Ft. Tunnel	745	200	83	835	600	30.1	26.8	1300	1235	24.7	450	14.2
AUGUST 1973 FLOOD ANALYSIS — RAINFALL EXCESS = 1.1 INCHES IN 3.25 HOURS												
Existing Conditions	190	0	76.3	225	130	29.0	22.0	350	250	21.0	335	11.0
With Upstream Improvements	190	0	76.3	225	-	22.4	22.2	455	300	22.0	364	12.0
Upstream Imp. + 12 Ft. Tunnel	190	0	76.3	225	225	22.2	20.9	455	415	20.0	220	9.7
10-YEAR FREQUENCY SYNTHETIC FLOOD — RAINFALL EXCESS = 2.2 INCHES IN 2 HOURS												
Existing Conditions	410	0	79.0	500	150	31.2	27.8	625	360	25.5	550	15.2
With Upstream Improvements	410	0	79.0	500	-	28.9	28.4	1009	420	28.1	566	15.4
Upstream Imp. + 12 Ft. Tunnel	410	0	79.0	500	500	25.6	23.9	1009	870	22.8	363	12.0
100-YEAR FREQUENCY SYNTHETIC FLOOD — RAINFALL EXCESS = 3.3 INCHES IN 2.5 HOURS												
Existing Conditions	620	30	81.0	750	170	32.6	29.8	880	400	28.0	720	16.2
With Upstream Improvements	620	30	81.0	750	-	30.5	30.2	1290	630	30.0	740	16.3
Upstream Imp. + 12 Ft. Tunnel	620	30	81.0	750	570	29.0	26.2	1290	1130	24.2	500	14.8

TABLE V

EFFECTS OF INITIAL STORAGE
AT OLD QUINCY RESERVOIR

MARCH 1968 FLOOD ANALYSIS

	Quincy Reservoir			Centre Street (Index #4)			Brook Road (Index #3)	M.T.A. Line (Index #2A)			Bigelow Street (Index #1)	
	Inflow (cfs)	Outflow (cfs)	Stage (msl)	Inflow	Outflow	Stage	Stage	Inflow	Outflow	Stage	Outflow	Stage
Existing Conditions (With Reservoir Initially Full)	356 (356)	150 (320)	82.5 (83.3)	355 (625)	180 (520)	33 (34.3)	27.6 (30.5)	430 (630)	330 (430)	24 (28)	425 (510)	13.2 (14.8)
With Upstream Improvements (With Reservoir Initially Full)	356 (356)	150 (320)	82.5 (83.3)	355 (625)	-	29 (30.3)	28.9 (30.1)	635 (825)	470 (675)	28.7 (30)	530 (730)	15.1 (16.2)
Upstream Imp. + 12 Ft. Tunnel (With Reservoir Initially Full)	356 (356)	150 (320)	82.5 (83.3)	355 (625)	355 (570)	24 (28)	22.5 (24.7)	635 (825)	630 (810)	21.5 (22.5)	220 (220)	9.7 (9.7)
10-YEAR FREQUENCY SYNTHETIC FLOOD												
Existing Conditions (With Reservoir Initially Full)	410 (410)	0 (210)	79.0 (82.8)	500 (560)	150 (170)	31.2 (32.8)	27.8 (28.3)	625 (625)	350 (350)	25.5 (25.5)	550 (555)	15.2 (15.3)
With Upstream Improvements (With Reservoir Initially Full)	410 (410)	0 (210)	79.0 (82.8)	500 (560)	- -	28.9 (29.2)	28.4 (28.8)	1009 (1030)	4[illegible]0 (437)	28.1 (28.6)	566 (568)	15.4 (15.4)
Upstream Imp. + 12 Ft. Tunnel (With Reservoir Initially Full)	410 (410)	0 (210)	79.0 (82.8)	500 (560)	500 (560)	25.6 (26)	23.9 (24.2)	1009 (1030)	870 (900)	22.8 (23.0)	363 (363)	12.0 (12.0)

NOTE: Base runs start with Old Quincy Reservoir initially at El. 73.4' NGVD
Comparative "Full" runs start with reservoir at spillway crest: El. 80.9' NGVD

11. FLOOD FREQUENCIES

Natural discharge frequency curves for Town Brook were established by assigning "Weibul" plotting positions to the seven annual peak flows of continuous record and associated plotting positions to the computed historical and synthetic floodflows. A natural discharge frequency curve was then fitted to all the plotted data as shown on Plate 8 for index stations 2 and 2A. Having established natural discharge frequencies, natural flood stage frequencies were developed using the established stage-discharge relationships.

Modified discharge frequency curves for varying plans of channel improvement were then developed by modeling a selected series of index floods under modified conditions. The selected flood series was the August 1955, 100-year synthetic, March 1968, 10-year synthetic and August 1973 storms. Plotted data for these floods, for the plan including both upstream improvements and tunnel, are illustrated on plate 8 for index stations 2 and 2A.

Natural and modified stage frequency curves at all four index stations are shown on plate 8 for the following conditions: (a) natural, (b) upstream improvements with no tunnel, (c) upstream improvements and 8-foot diameter tunnel, and (d) upstream improvements and 12-foot diameter tunnel. These stage frequency curves were developed for use by others in establishing the economic feasibility of the planned and proposed system of improvements for flood control on Town Brook.

12. TIDE LEVELS

Town Brook discharges to tidewater in Town River Bay. Tide levels in Town River Bay are similar to those at Boston, about 8 miles north, where tide records have been kept since 1848. Pertinent tide data, listed in Table VI, include estimated tide stage frequencies based on a 1979 update and review study by the Hydraulics and Water Quality Section of the Water Control Branch, New England Division, Corps of Engineers. The highest observed tide of record occurred in February 1978 when a severe northeast coastal storm produced a tide of 10.3 feet NGVD.

TABLE VI
PERTINENT TIDE DATA
BOSTON HARBOR, MASS.

Tide	Stage (Ft. above NGVD)
Mean Tide Range	9.5 (Feet)
Mean High Tide	4.9
High Spring Tide	7.1
2 yr	8.2
10 yr	9.1
50 yr	10.0
100 yr	10.3

The hydrologic analysis of the Town Brook tunnel was based on an assumed coincident high tide in Town River Bay of elevation 7 feet NGVD for those plans discharging upstream of the Southern Artery. With the selected tunnel plan, the discharge capacity would be reduced about 3 percent for every foot the coincident tide was above 7 feet NGVD and similarly the capacity would be increased somewhat if the coincident tide was below 7 feet NGVD. Under conditions of a coincident 100-year tide the discharge capacity of the tunnel would be approximately 90 percent of design.

13. STANDARD PROJECT FLOOD

The Standard Project Flood for Town Brook was developed by applying the Standard Project Storm rainfall excess of 10.3 inches to the developed HEC-1 computer models, both for existing and improved conditions. With such a storm centered over the Town Brook watershed the resulting flood discharges were 2 to 2.5 times the computed discharges for the 1955 flood of record or the 100-year storm flood, far exceeding the capacity of any planned improvements by others. Under such a flood condition, a major portion of the flow would be overland across highways and around buildings, making computed stage-discharge relations rather inprecise. However, the computed SPF flows and stages for various levels of improvement are tabulated in Table VII. It is noted that with planned improvements upstream and a proposed 12 foot diameter tunnel, the SPF flood level would be reduced approximately 1, 1.5, 2, and 3 feet at index stations 4, 3, 2A and 2, respectively. Considerable residual flooding would occur with a standard project flood but such flooding would not be of a depth or velocity to produce a catastrophe. A 15-foot diameter tunnel would be required to convey the SPF, however, increasing the proposed tunnel size from 12 to 15 feet in diameter was found to have little added effect on flood stages, except right at the tunnel entrance, due to limited conveyance of waters to the tunnel plus the fact that the 12-foot tunnel was adequate under SPF conditions to prevent appreciable flows from passing the MBTA line and entering downtown Quincy.

Assumed upstream improvements consisted of one 8' x 10' auxiliary conduit plus an improved 8' x10' Town Brook channel providing a maximum capacity to the tunnel of about 1,200 cfs. It was found that twice this capacity or the equivalent of 4-8'x10' conduits would be required to convey the SPF discharge of 2,400 cfs to the tunnel. Designing the Town Brook Tunnel for the standard project flood was not considered practical.

TABLE VII
STANDARD PROJECT FLOOD
RAINFALL EXCESS = 10.3 INCHES

	Existing Conditions	Upstream Imp. +12 ft. Tunnel	Upstream Imp. +15 ft. Tunnel
Quincy Res.			
Inflow (cfs)	1370	1370	1370
Outflow (cfs)	975	1180	1180
Stage (NGVD)	83.5	83.0	83.0
Centre St. (Index #4)			
Inflow (cfs)	1950	2360	2360
Outflow (cfs)	1870	2000	2000
Stage (NGVD)	36±	35±	35±
Brook Rd. (Index #3)			
Stage (NGVD)	34±	32.5±	32.0
M.T.A. Line (Index #2A)			
Inflow (cfs)	2440	2460	2460
Outflow (cfs)	1590	1920	2400
Stage (NGVD)	32±	30±	26±
Bigelow St. (Index #2)			
Outflow (cfs)	1620	750	750
Stage (NGVD)	19±	16±	16±

14. PROJECT DESIGN FLOOD

The Project Design Discharge, the capacity of the finally selected 12-foot diameter Town Brook Tunnel, is approximately 1,200 cfs with a head-water level of not over 24 feet NGVD and a coincident tailwater level of 7 feet NGVD. With this capacity, the project design flood is equal to the recurring August 1955 flood of record, or comparable 100 year frequency storm runoff, under conditions with the planned upstream auxiliary conduit by others plus projected future improvements in the existing Town Brook Channel providing project design flood conveyance to the tunnel entrance with a minimum of ponding. Though smaller tunnels were analyzed the 12-foot tunnel was selected as being both economical and compatible with the capacity of all projected upstream improvements. Though it was not considered prudent to design the tunnel for less than the projected upstream inflow capacity, it was also considered impractical to provide tunnel capacity greatly in excess of projected inflow capacity. The selected project design flood discharge of 1,200 cfs is about four times the capacity of the existing Quincy conduit.

15. SELECTED TUNNEL DESIGN

a. General. Tunnel plans discharging to Town River upstream of the Southern Artery varied in length from 3,500 to 4,000 feet depending on the point of discharge upstream of the Southern Artery. Any reduced head loss in the shorter tunnel plans tended to be offset, however, by increased open channel flow distance, and associated hydraulic losses, to the Southern Artery. The hydraulic capacity of the tunnel was therefore based on a hydraulic length of 3,800 feet. The tunnels were assumed to be either concrete lined or smooth bored, providing a Manning's "n" roughness coefficient of not less than 0.015. Entrance and exit loss coefficients were 0.5 and 1.0, respectively. With the selected 12-foot diameter tunnel, the resulting discharge capacity formula was:

Q	=	$333\sqrt{\Delta H}$
Q	=	discharge in cfs
AH	=	difference between headwater and tailwater levels, in feet

Design velocities in the tunnel would be 10 to 11 feet per second.

b. Inlet. The inlet to the proposed 12-foot diameter tunnel was designed to: (1) provide for inflows from the 8' by 10' auxiliary conduit by others, (2) provide for the passage of normal brook flows while allowing for excess flows to enter the tunnel, (3) serve as a sediment trap for normal to moderate flood flows and (4) be hydraulically efficient while being conservative in size and cost. The proposed inlet will consist of a 20 foot diameter morning glory structure centered in a 32 foot by 32 foot box. The 8 foot x 10 foot auxiliary conduit will enter the box from the south, both having a common invert elevation of 13 feet NGVD. The lip of the morning glory would be at elevation 15 NGVD. The box and lower reach of the conduit will therefore serve as a sediment trap during low to moderate flows, but the capacity of ther 12-foot morning glory will be adequate to pose no restriction to the capacity of the auxiliary conduit during high flows.

The inlet box will also be equipped with weir inlets on the north and westerly sides, with lip elevations at 19 feet NGVD, to permit excess flood flows to enter from existing Town Brook channel. The existing Town Brook channel invert is about 16 feet NGVD. Therefore, normal flows up to 3 feet will be conveyed in the channel before diversion to the tunnel. The effective weir length will be about 40 feet, thus providing adequate inlet capacity once stages in the brook exceed 19 feet, with little further increase in stage.

With planned improvements in the existing Town Brook channel, the design discharge of 1,200 cfs is expected to be quite equally proportional between inflow from the auxiliary conduit and the existing Town Brook channel. That is, 600 cfs would enter via the 8-foot x 10-foot auxiliary conduit from the south and 600 cfs from the improved Town Brook channel.

The design head at the inlet under project design conditions would be between 23 and 24 feet NGVD with a coincident tunnel tailwater at elevation 7 feet NGVD. A plan and section of the inlet structure is shown on Figure F-2 of Appendix F.

c. Outlet. The outlet of the tunnel will consist of a 12-foot diameter vertical riser transitioning into a horizontal apron with an invert at elevation +2 feet NGVD. The apron will have 5 to 10 foot wide bays providing a total horizontal flow width of 50 feet. Design velocity in the riser would be 10 to 11 feet per second and velocities over the end sill with a design tailwater of 7 feet NGVD would be about 3 feet per second. Under a condition of coincident low tide velocities over the end sill, at a critical depth of 2.6 feet, would be approximately 9 feet per second. A plan and profile of the tunnel outlet structure is shown on Figure F-3 of Appendix F.

From the tunnel outlet structure, flows will be conveyed in a 50-foot wide trapezoidal channel with an invert elevation of +1 foot NGVD and 2 horizontal to 1 vertical riprapped side slopes. This improved channel will continue to the existing Town Brook channel and towards the Southern Artery highway, to the point where the existing Town Brook channel, and adjacent wetlands, provide a minimum cross sectional flow area below elevation +7 foot NGVD of 350 square feet. Easements or purchase of the wetlands will be required from the end of the 50-foot trapezoidal channel to the Southern Artery to insure preservation of the required flow area. Design flow velocities in both the trapezoidal discharge channel and existing Town Brook channel will be in the order of 3.5 to 4.5 feet per second resulting in a hydraulic head loss in the order of 0.5 feet per thousand feet.

At the Southern Artery highway, and adjacent parking lot, the present very restrictive culverts will be replaced with triple 8-foot high by 14-foot wide rectangular conduits providing a cross sectional flow area of 336 square feet. With a total flow of 1,600 cfs - 1,200 cfs from the tunnel and 400 cfs residual from Town Brook - the velocity in the conduits will be about 4.7 feet per second. The invert of the conduits will slope from -1 ft NGVD at the entrance to -2 ft NGVD at the outlet. The outlets of the Southern Artery conduits will be equipped with flap gates with 2-foot openings at the bottom. These gates will serve to maintain the present tidal environment in the upstream Town Brook wetland while providing the necessary increased flood outflow capacity.

Floodflow conveyance downstream from the Southern Artery to Town River Bay will be provided by a 40-foot minimum width channel having at least 350 square feet of flow area between an invert of -3 feet NGVD and a design tide level of +6 ft. NGVD.

16. RESERVOIR IMPROVEMENTS

a. General. As part of the flood control plan for Town Brook, it is proposed that the Corps of Engineers perform improvements at Old Quincy Reservoir to insure its structural and operational integrity for flood control.

As previously discussed, the project presently provides a degree of flood control due to its surcharge storage capabilities and by maintenance of the pool drawndown at approximately 7.5 feet. Improvements at the dam will consist of:

(1) Structurally reinforcing the downstream face of the dam

(2) Providing a new and enlarged spillway

(3) Constructing a low dike along the left side of the reservoir to the elevation of the top of dam. Flood flows presently overflow from the reservoir on to Lakeside Drive and around the dam

(4) Including a low level permanent pool weir and outlet orifice to provide automatic flood control regulation. The present "hit or miss" operation for pool regulation consists of the operator periodically observing the level of the reservoir and making adjustments in the setting of the 12-inch low level outlet.

b. Flood Control Capacity. Old Quincy Reservoir presently has 250 acre-feet of flood control storage between the minimum normal pool level at elevation 73.4 feet NGVD and the spillway crest at elevation 80.9 feet NGVD. This storage is equivalent to 3 inches of runoff from the contributing watershed and will be maintained by constructing a permanent pool weir at elevation 73.4 feet and the new emergency spillway at elevation 80.9 feet NGVD. This storage is adequate to provide either complete control or appreciable modification and desyncronization of all floods from the contributing watershed, up to the magnitude of the flood of record. Floods such as the record 1955 flood, recurring, would fill the reservoir and result in some spillage but the spillage would be in the order of 320 cfs compared to a peak inflow in the order of 750 cfs, and the reservoir would serve to completely desyncronize the peak outflow with the peak flood runoff from downstream areas. This desyncronizing effect is hydrographically illustrated on Plate 7.

c. Spillway Design. The new spillway at Old Quincy Reservoir will have a 120-foot long ungated box type overflow weir at elevation 80.9 feet NGVD. It will replace the old spillway which will be made inoperable. The new spillway will be designed to discharge the maximum probable flood discharge without the pool level exceeding top of dam (elevation 85 feet NGVD). The existing spillway crest elevation at the reservoir is elevation 80.9 feet NGVD, and the maximum height of dam will be 85 feet NGVD, after construction of a dike along the north bank of the reservoir. Raising the dam higher than 85 feet NGVD was engineeringly not feasible because the dike could not be tied into high ground if it were constructed at higher elevations. Also lowering the existing spillway below elevation 80.9 feet NGVD was considered unwise since this would result in loss of already quite limited regulated flood control storage. Therefore, the distance between spillway crest and maximum top of dam was limited to 4.1 feeet, the difference between elevation 85 and 80.9 feet.

With only 4.1 feet of range, it was not possible to provide the commonly adopted 5 feet of freeboard above the Probable Maximum Flood Level (PMF) or even the usually minimum 3 feet of freeboard, without installing an unreasonably long spillway. It is noted that as the spillway is lengthened, it is not only more costly, but it allows increased downstream flows per increment of surcharge if, and when, the spillway level is exceeded. Therefore, a spillway length that provides a high degree of safety but also allows for reasonable use of surcharge storage for flood attenuation was considered advisable. The adopted new spillway, with a length of 120 feet, will provide capacity for the Probable Maximum Flood discharge with 3.8 feet of surcharge and 0.3 feet of freeboard. Wave action was not considered a major factor since fetch distances are less than 2,000 feet and such a pool level would be maintained for only a 1 to 2-hour duration if such an event were to occur. With the adopted spillway, the project could discharge a Standard Project Flood (SPF) with a surcharge of 2.4 feet and a freeboard of 1.7 feet. This freeboard, though small, represents approximately 70 percent of the SPF surcharge.

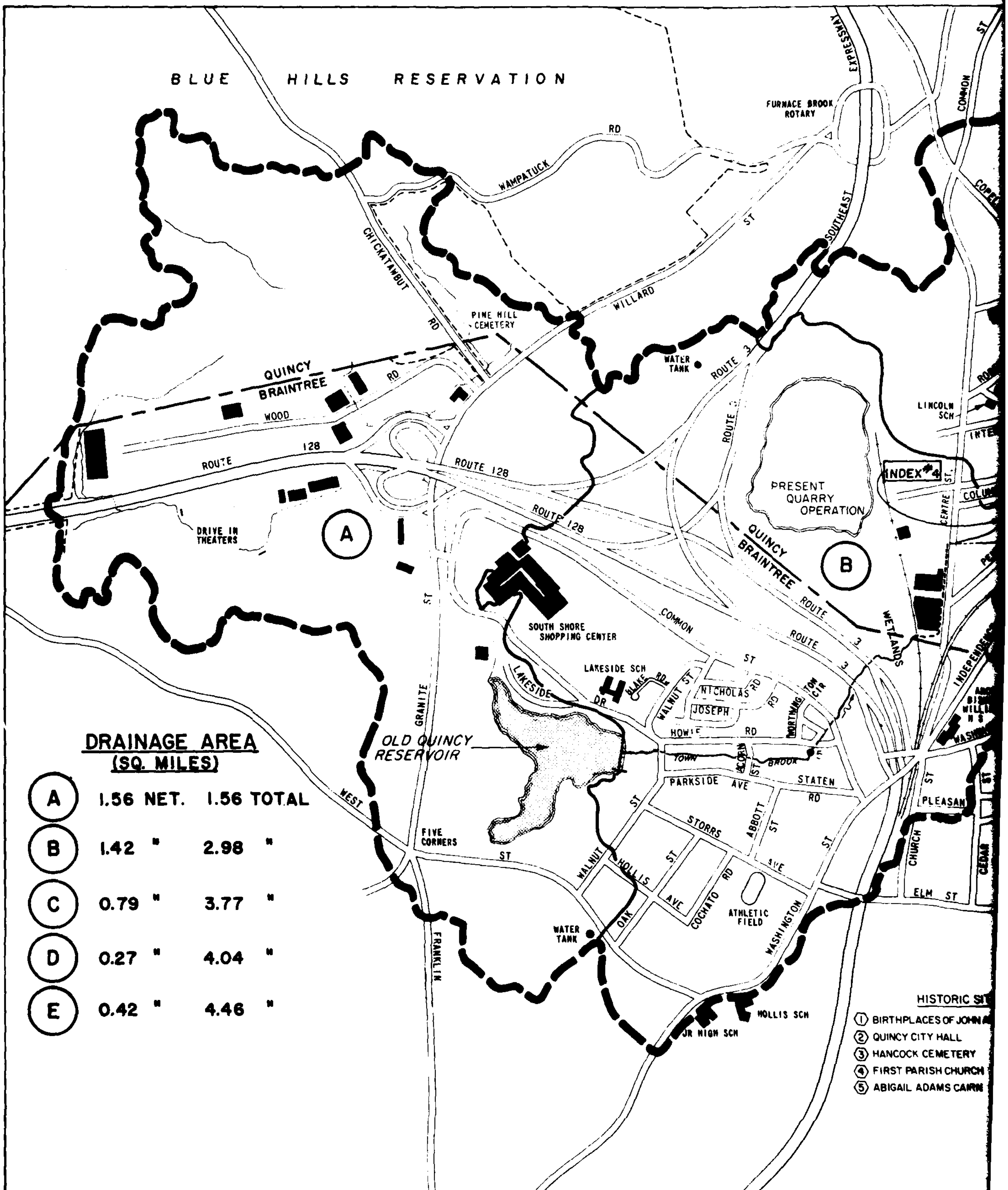
The spillway design and freeboard criteria adopted for the renovation of Old Quincy Reservoir is comparable to that used for the nearby small flood control reservoirs recently completed by the New England Division Corps of Engineers on Hayward Creek and Smelt Brook in Braintree, Massachusetts.

The PMF inflow was computed by peaking the developed unit graph 50 percent in accordance with (EM 1110-2-1405) and applying the probable maximum storm rainfall excess of 20.4 inches. The PMF rainfall was determined from HMS #33 and adjusted for the size of the watershed in accordance with CEC 1110-2-27. The resulting hydrograph was routed through surcharge storage assuming the reservoir initially filled to spillway crest and an average weir coefficient of 3.5. The resulting peak outflow was 3,140 cfs with a maximum pool elevation of 84.7 feet NGVD. The standard project flood was also developed and similarly routed through the project. The resulting maximum SPF pool level was elevation 83.3 feet NGVD or 1.7 feet below top of dam.

Analyses of both the MPF and SPF-floods are hydrographically illustrated on Plate 11, including a spillway length-surcharge curve and a spillway rating curve. A plan and profile of the spillway is shown on Figure F-4 in Appendix F.

d. Permanent Pool Weir and Outlet. A weir discharging to an orifice outlet will be located on the upstream side of the spillway structure to provide a means of maintaining the normal pool relatively constant at 73.4 feet NGVD and the orifice outlet will provide automatic regulation for flood control. The weir at elevation 73.4 feet NGVD will have a 25-foot ungated overflow length discharging to two 1 foot by 1.5 foot rectangular openings through the spillway. The twin orifices will be at invert elevation 71 feet NGVD and will provide a regulated outflow of 50 cfs with the flood control pool filled to spillway crest (elevation 80.9 NGVD), based on a discharge coefficient of 0.7 in the basic orifice equation $Q = CA\sqrt{2gH}$. A plan and

profile of the permanent pool weir and outlet are shown on Figure F-4 in Appendix F. It is noted that the existing low level outlet works will continue to be maintained by the owner, for purposes of withdrawing water for industrial supply, downstream releases, or drawdown of the impoundment below 73.4 feet NGVD.


BLUE HILLS RESERVATION
FURNACE BROOK ROTARY
SOUTHEAST EXPRESSWAY
WAMPATUCK RD
WILLARD ST
CHICKATAWBUT RD
PINE HILL CEMETERY
QUINCY
BRAINTREE
WOOD RD
ROUTE 128
ROUTE 128
ROUTE 128
DRIVE IN THEATERS
WATER TANK
ROUTE 3
PRESENT QUARRY OPERATION
LINCOLN SCH
INDEX #4
CENTRE ST.
COMMON ST
SOUTH SHORE SHOPPING CENTER
COMMON ST
ROUTE 3
WETLANDS
LAKESIDE SCH
LAKESIDE DR
BLAKE RD
WALNUT ST
NICHOLAS RD
JOSEPH
HOWIE RD
OLD QUINCY RESERVOIR
TOWN BROOK
PARKSIDE AVE
STATEN RD
GRANITE ST
WEST ST
FIVE CORNERS
STORRS AVE
ABBOTT ST
HOLLIS AVE
OAK
COCHATO RD
ATHLETIC FIELD
WASHINGTON ST
WATER TANK
FRANKLIN
JR HIGH SCH
HOLLIS SCH
CHURCH
PLEASANT
ELM ST
CEDAR
INDEPENDENCE
A
B
DRAINAGE AREA (SQ. MILES)
A 1.56 NET. 1.56 TOTAL
B 1.42 " 2.98 "
C 0.79 " 3.77 "
D 0.27 " 4.04 "
E 0.42 " 4.46 "
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2 QUINCY CITY HALL
3 HANCOCK CEMETERY
4 FIRST PARISH CHURCH
5 ABIGAIL ADAMS CAIRN

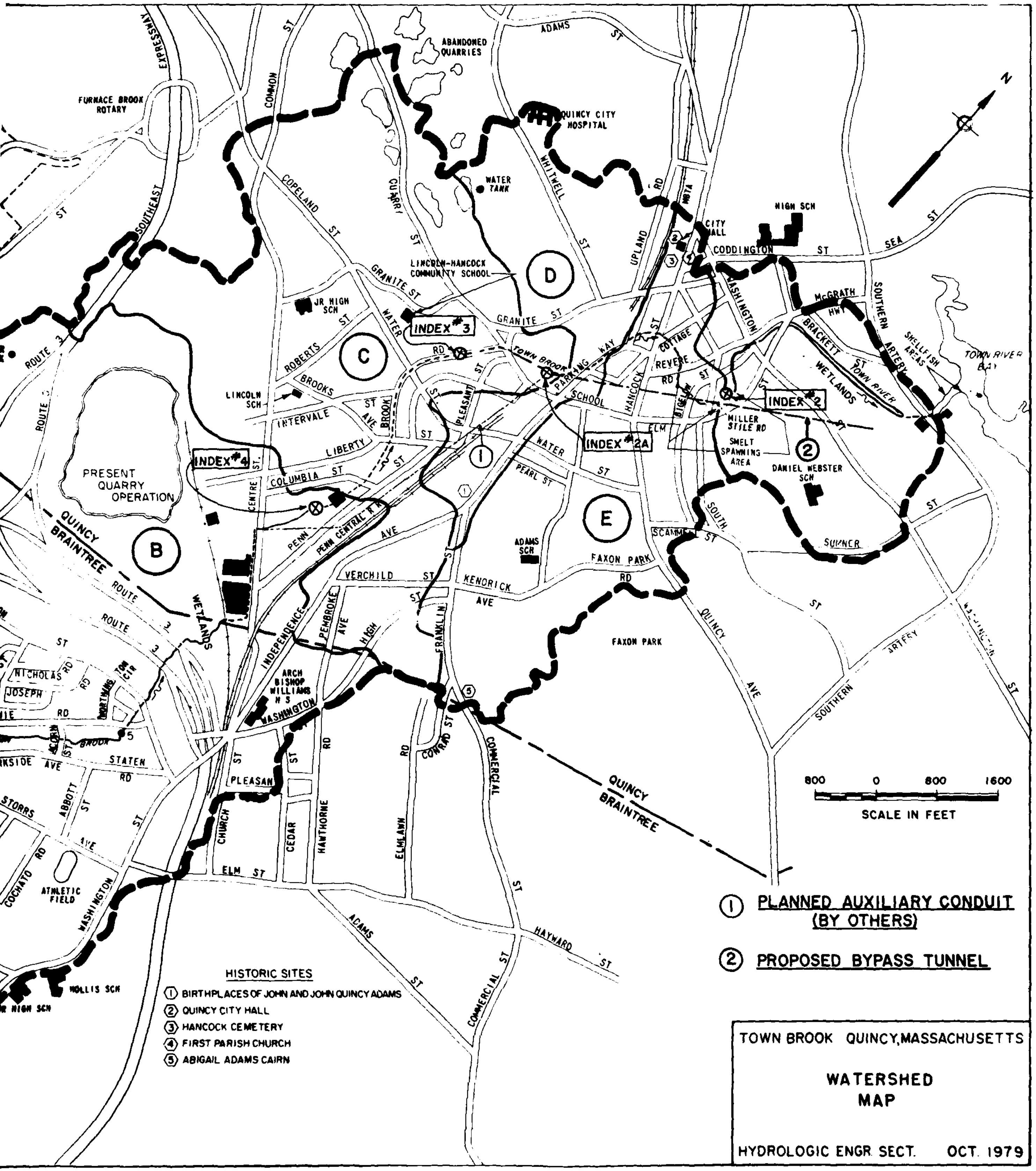
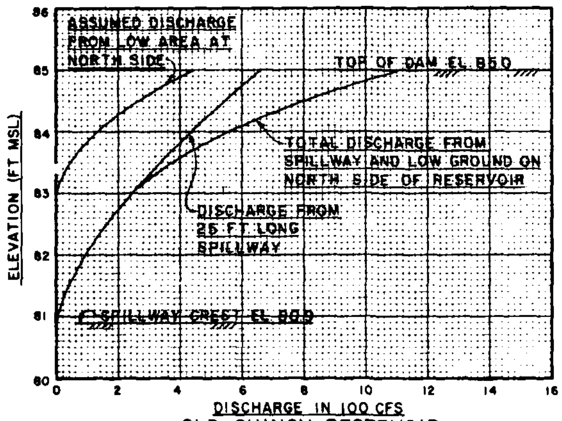
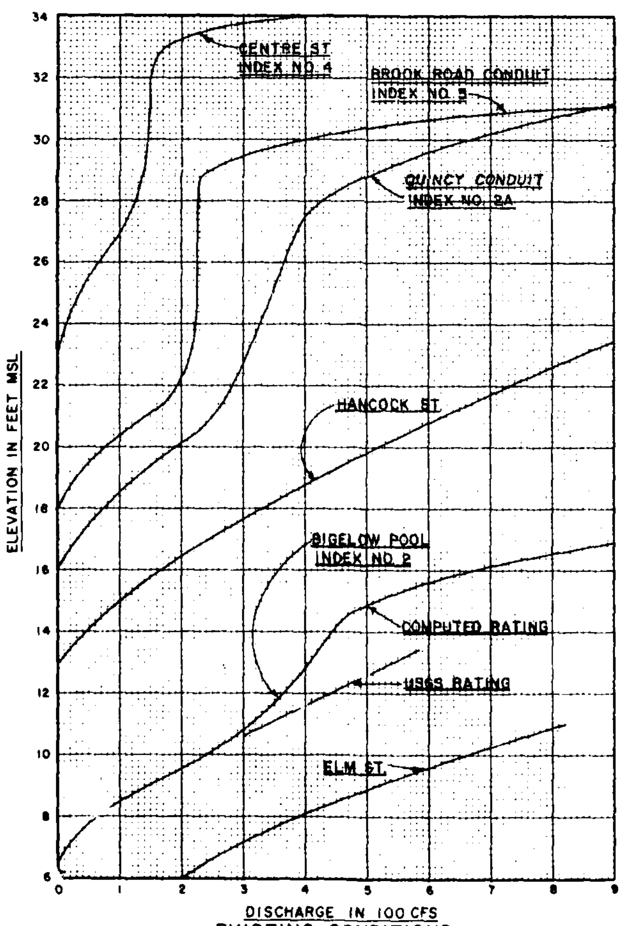

TOWN BROOK QUINCY, MASSACHUSETTS
WATERSHED
MAP
HYDROLOGIC ENGR. SECT. OCT. 1979
① PLANNED AUXILIARY CONDUIT (BY OTHERS)
② PROPOSED BYPASS TUNNEL
HISTORIC SITES
① BIRTHPLACES OF JOHN AND JOHN QUINCY ADAMS
② QUINCY CITY HALL
③ HANCOCK CEMETERY
④ FIRST PARISH CHURCH
⑤ ABIGAIL ADAMS CAIRN
800 0 800 1600
SCALE IN FEET
N
INDEX #2
INDEX #2A
INDEX #3
INDEX #4
B
C
D
E
PRESENT QUARRY OPERATION
ABANDONED QUARRIES
QUINCY CITY HOSPITAL
WATER TANK
FURNACE BROOK ROTARY
SOUTHEAST EXPRESSWAY
LINCOLN-HANCOCK COMMUNITY SCHOOL
JR HIGH SCH
LINCOLN SCH
CITY HALL
HIGH SCH
DANIEL WEBSTER SCH
SMELT SPAWNING AREA
MILLER STILE RD
ADAMS SCH
ARCH BISHOP WILLIAMS H S
HOLLIS SCH
JR HIGH SCH
ATHLETIC FIELD
FAXON PARK
SHELLFISH AREAS
TOWN RIVER BAY
TOWN RIVER
BRACKETT ST WETLANDS
TOWN BROOK
QUINCY BRAINTREE
WETLANDS
PENN CENTRAL R R
ROUTE 3

PLATE I

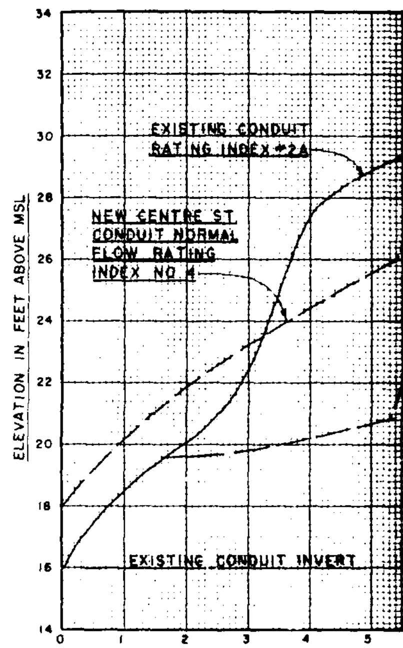
CORPS OF ENGINEERS



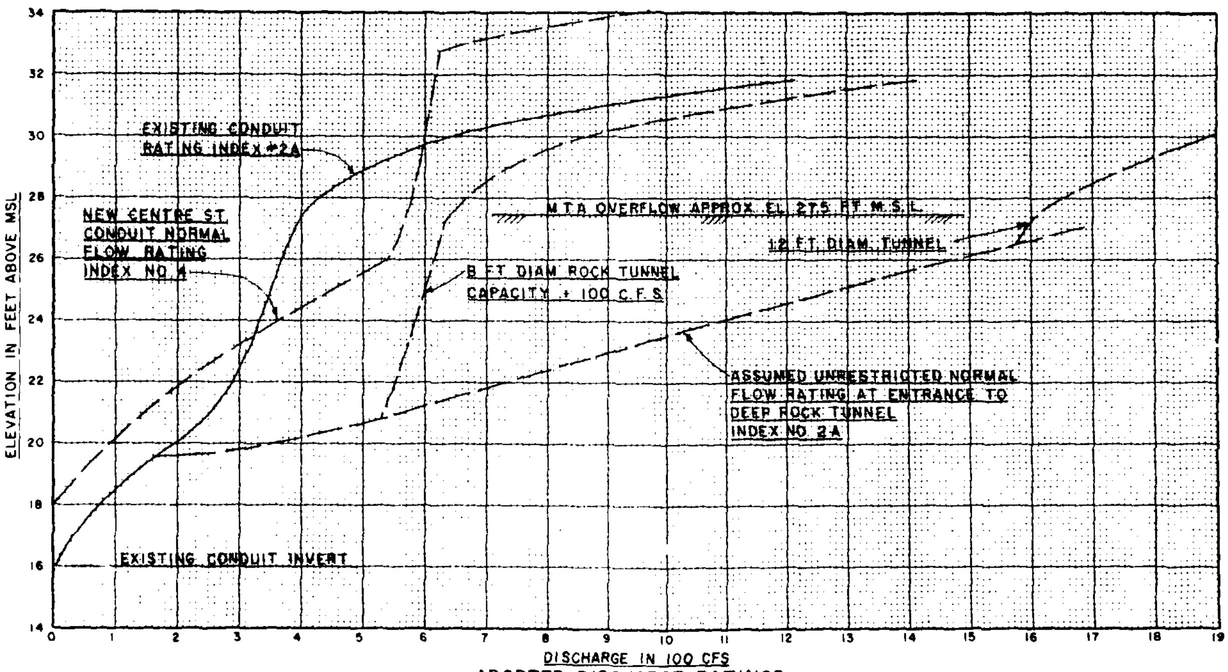
OLD QUINCY RESERVOIR



EXISTING CONDITIONS
RATING CURVES



U. S. ARMY



ADOPTED DISCHARGE RATINGS
WITH IMPROVED CONDITIONS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

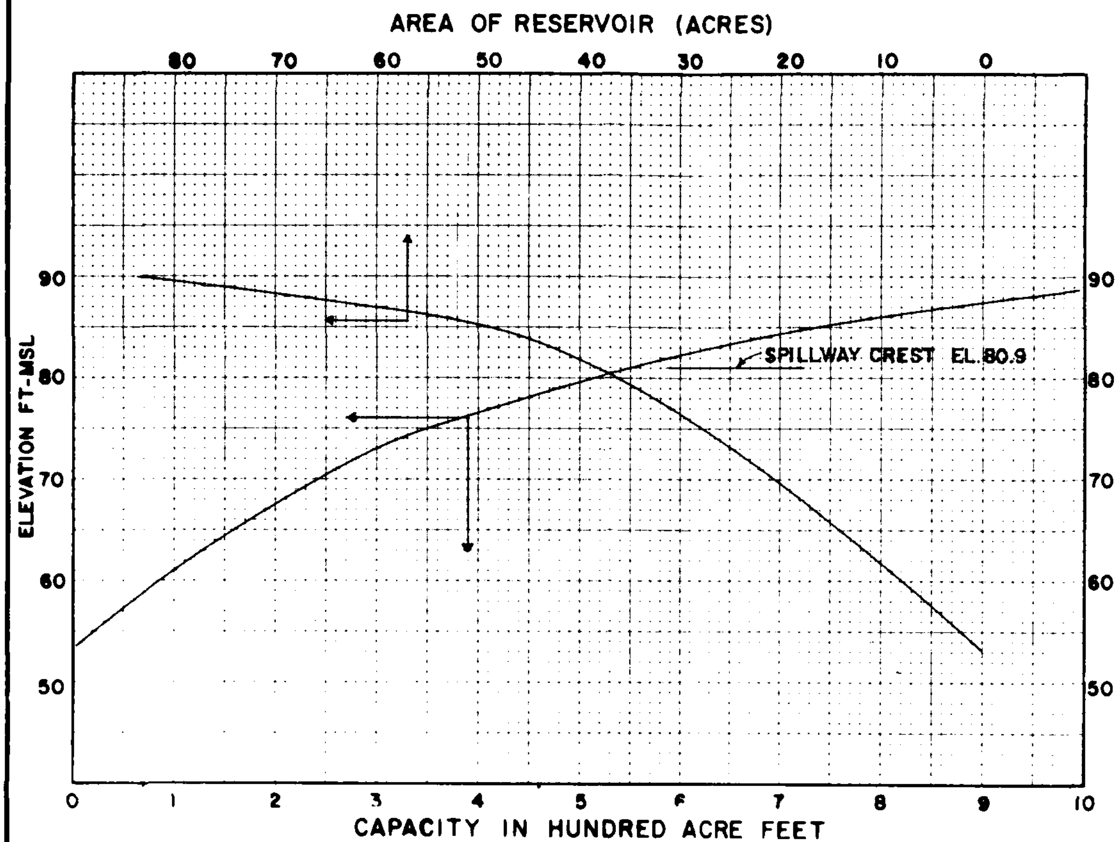
TOWN BROOK QUINCY, MASSACHUSETTS

DISCHARGE
RATING CURVES

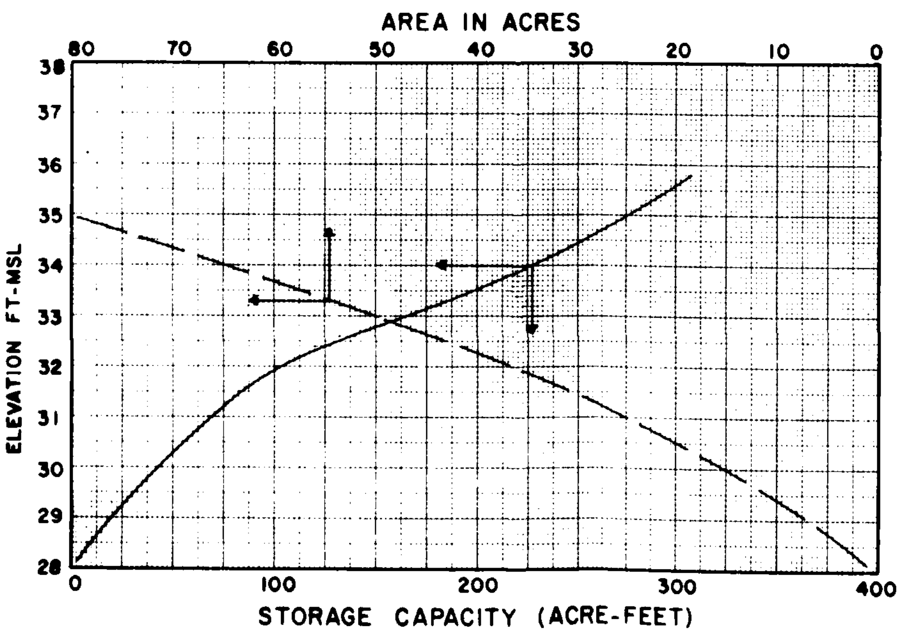
HYDROLOGIC ENGINEERING SECTION SEPT 1979

PLATE 2

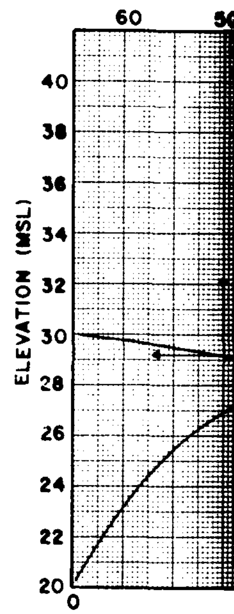
2

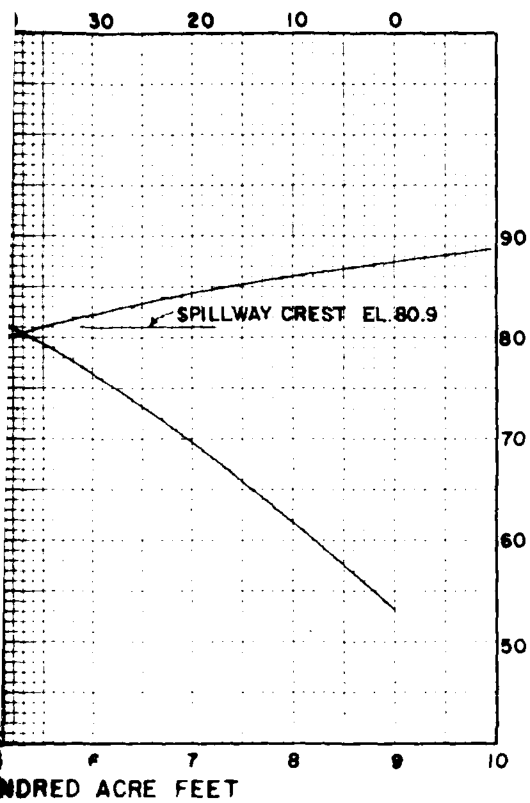


OLD QUINCY RESERVOIR

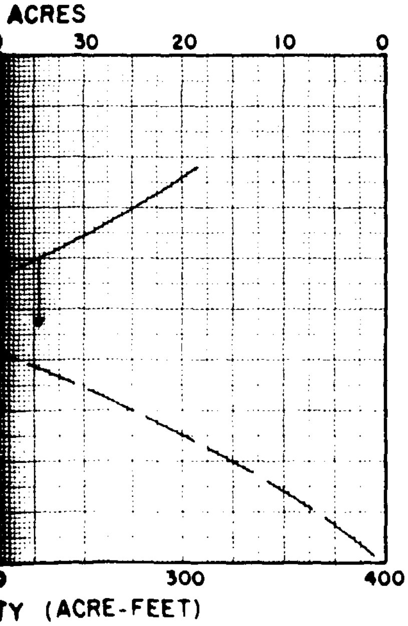


CENTRE STREET POOL

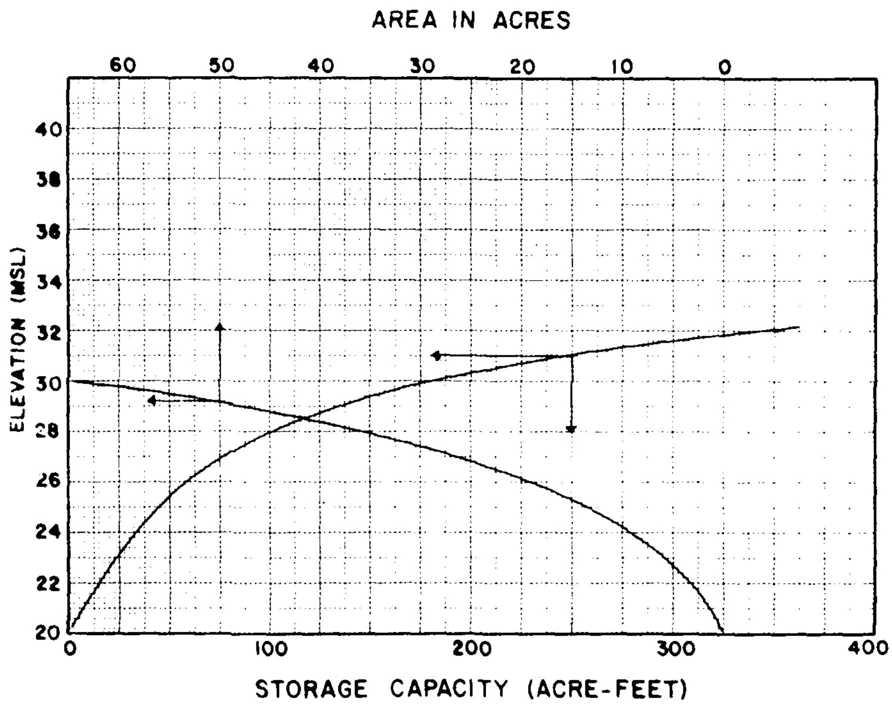




RESERVOIR



REET POOL



BROOK ROAD POOL

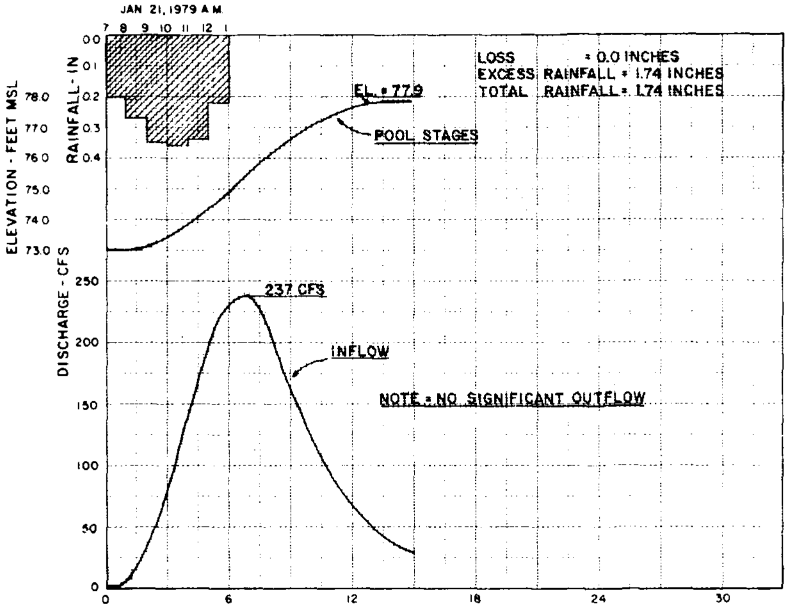
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DRAWN BY	TOWN BROOK QUINCY, MASS.
TRACED BY	STORAGE-CAPACITY CURVES
CHECKED BY	
APPROVED	HYDRO. ENGR. SECT. SEPT. 1979
	SCALE DATE
	SHEET OF

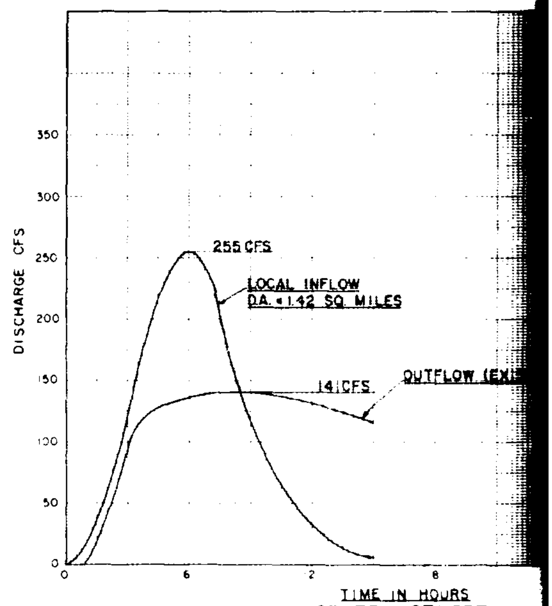
PLATE 3

2

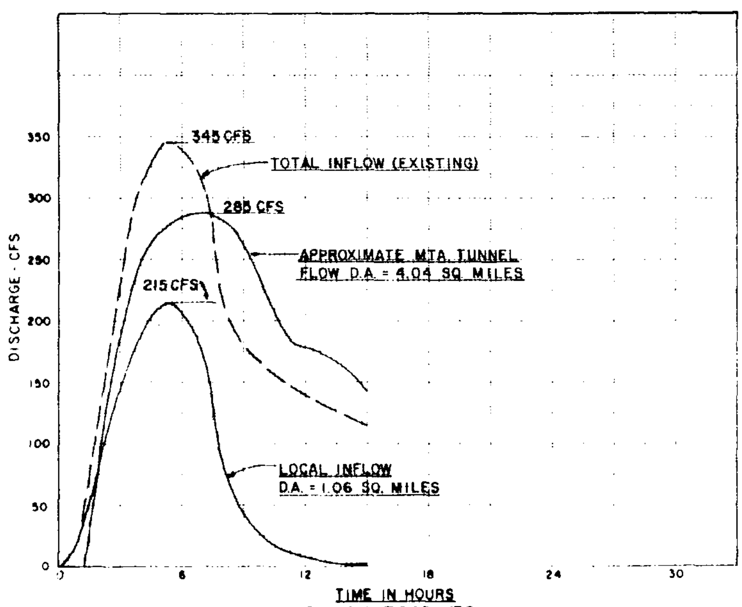
CORPS OF ENGINEERS



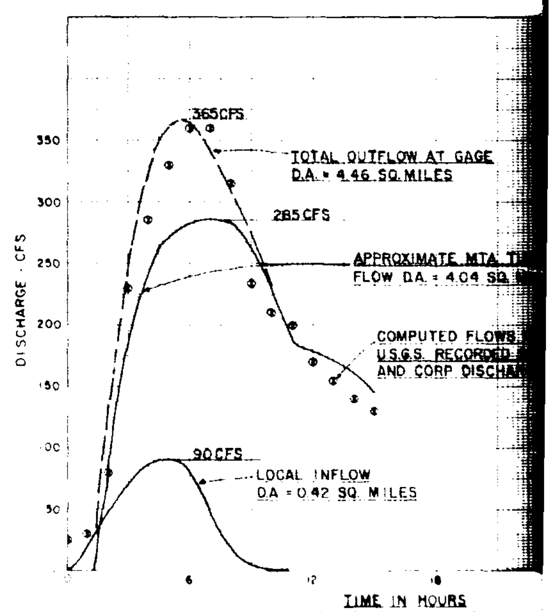
OLD QUINCY RESERVOIR
D.A. = 1.56 SQ MILES



CENTRE STREET
D.A. = 2.98 SQ MILES

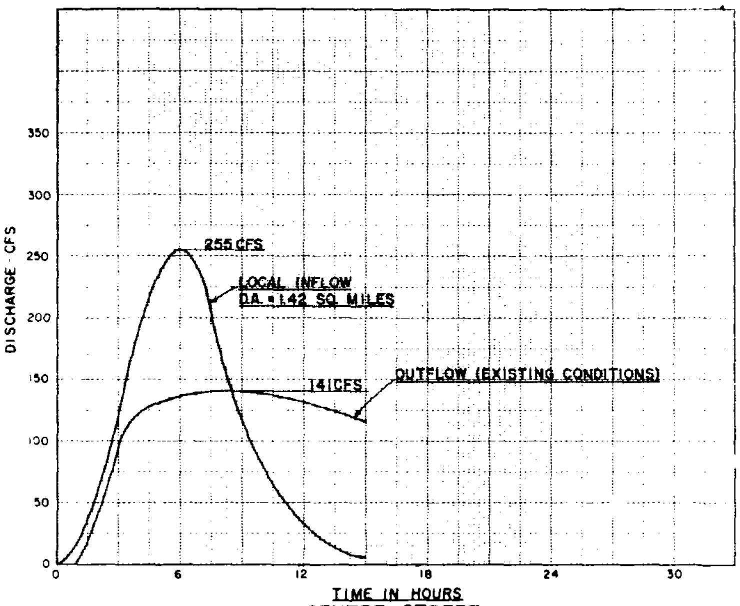


BROOK ROAD TO
M T A TUNNEL ENTRANCE
D.A. = 4.04 SQ MILES

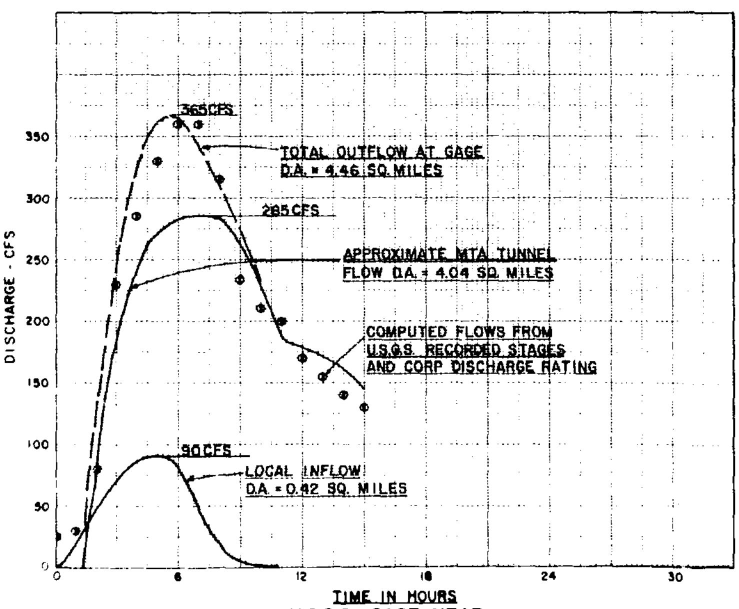


USGS GAGE NEAR
BIGELOW STREET
D.A. = 4.46 SQ MILES

U. S. ARMY



CENTRE STREET
D.A. = 2.98 SQ. MILES



U.S.G.S. GAGE NEAR
BIGELOW STREET
D.A. = 4.46 SQ. MILES

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

JANUARY 1979 FLOOD
ANALYSIS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

APPROVED DATE

CHIEF, ENGINEERING DIVISION

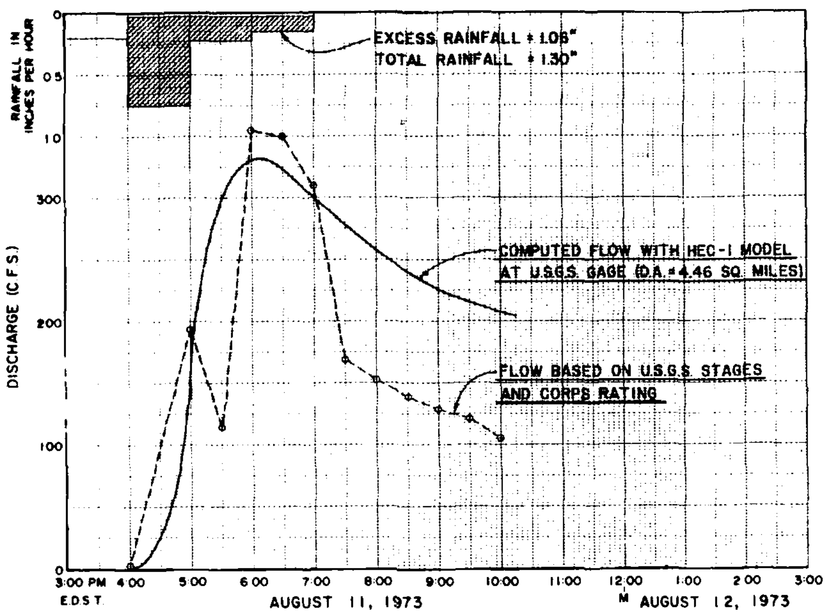
SCALE SPEC. NO.

DRAWING NUMBER

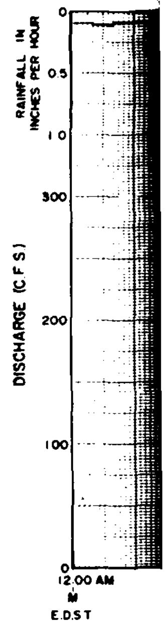
SHEET

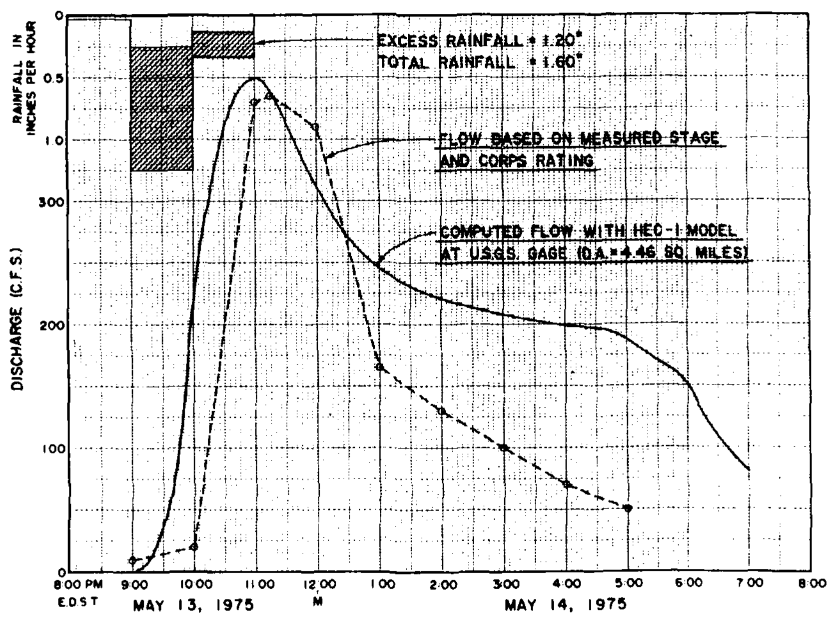
PLATE 4

2



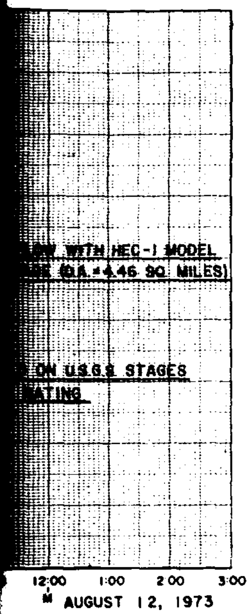
RAINFALL - RUNOFF

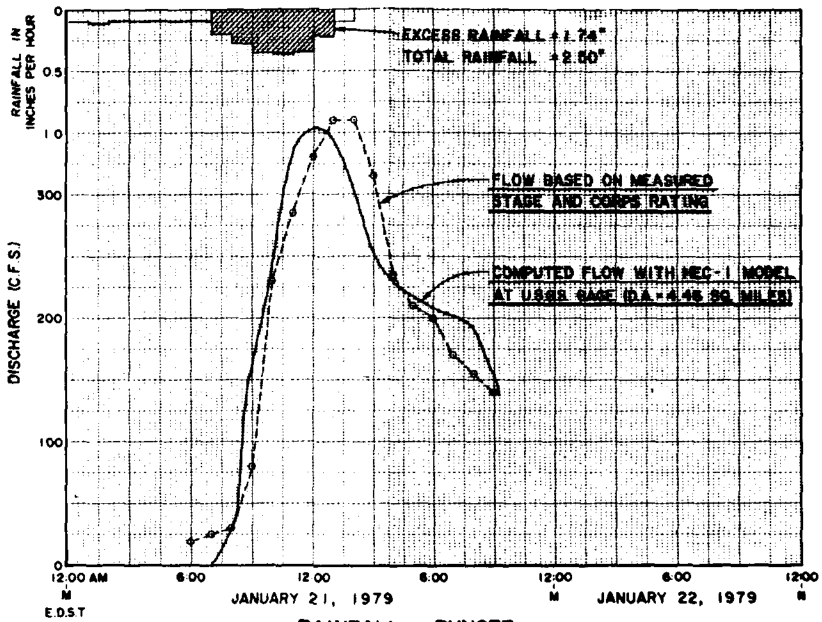




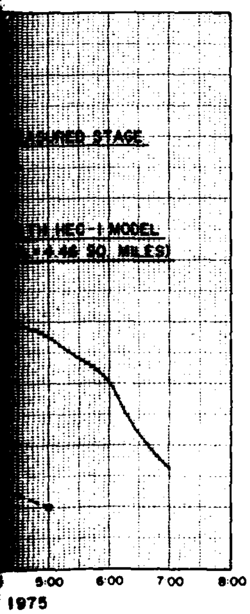
RAINFALL - RUNOFF

U. S. ARMY





RAINFALL - RUNOFF



REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

STORM RUNOFF COMPARISONS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

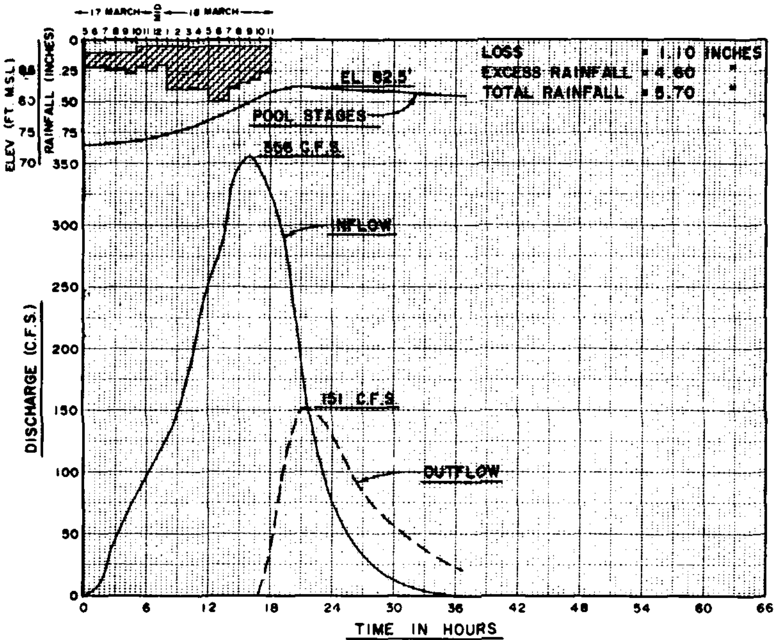
APPROVED DATE

SCALE SPEC. NO.

DRAWING NUMBER

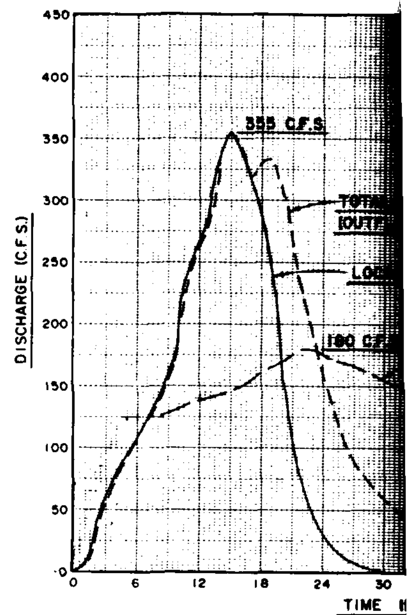
SHEET

PLATE 5



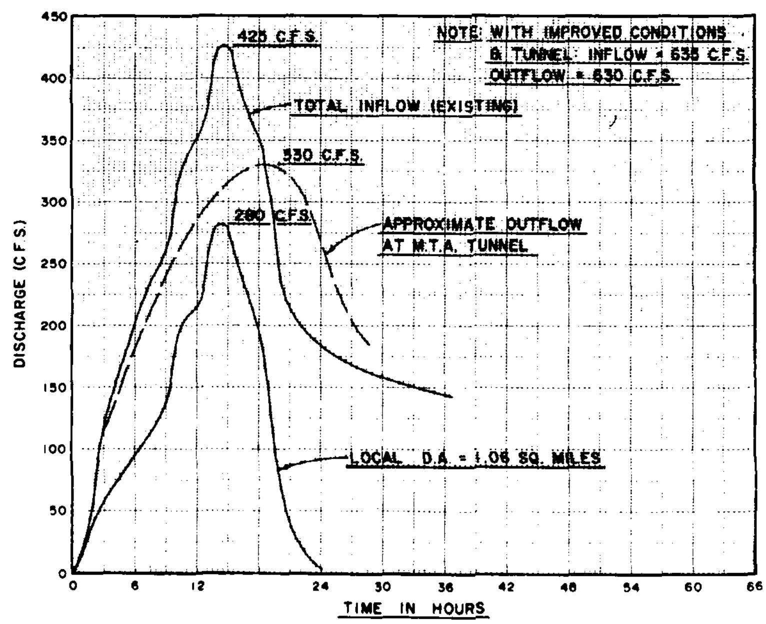
QUINCY RESERVOIR

D.A. = 1.56 SQ MILES



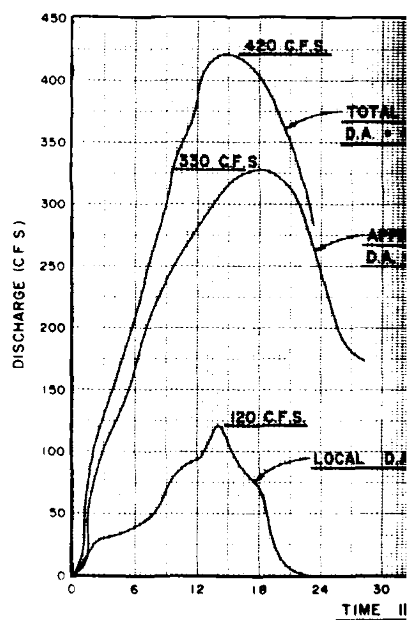
CENTRE

D.A. = 2.9



BROOK ROAD TO
M.T.A. TUNNEL ENTRANCE

D.A. = 4.04 SQ MILES

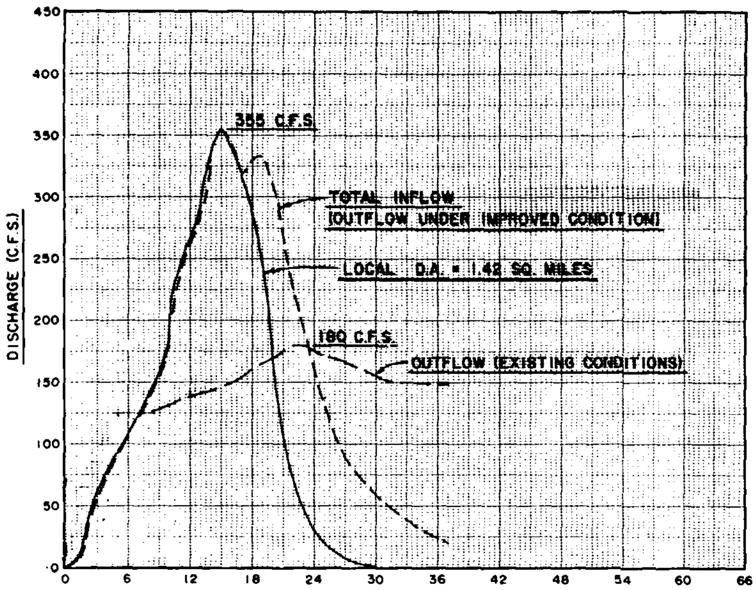


U.S.G.S. G

BIGELOW

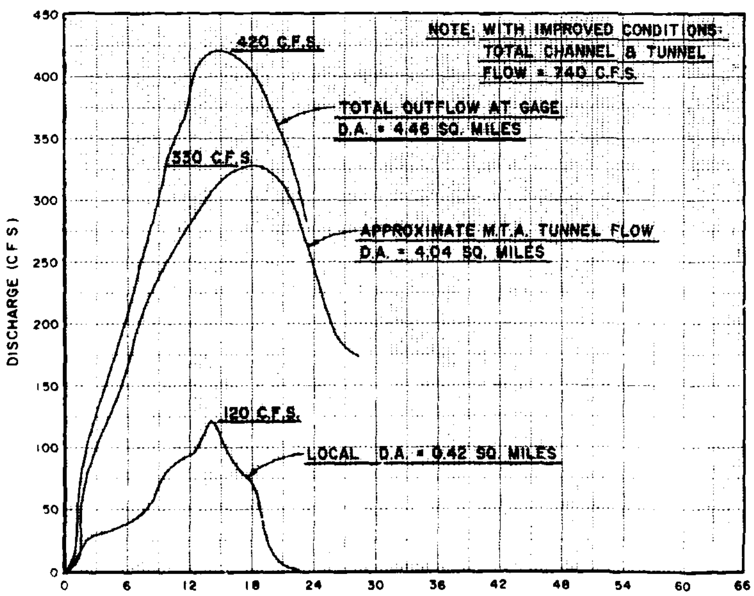
D.A. = 4.4

U. S. ARMY



CENTRE STREET

D.A. = 2.98 SQ. MILES



U.S.G.S. GAGE NEAR
BIGELOW STREET

D.A. = 4.46 SQ. MILES

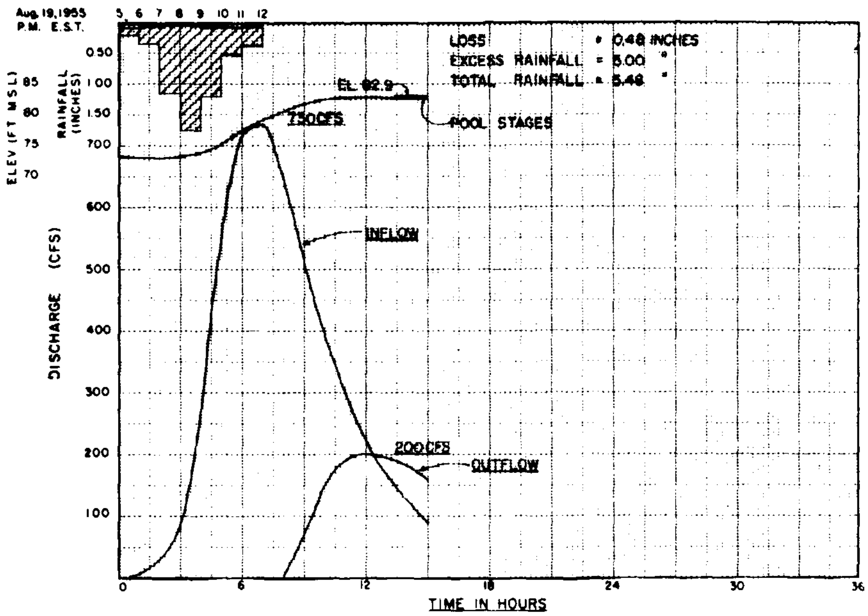
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

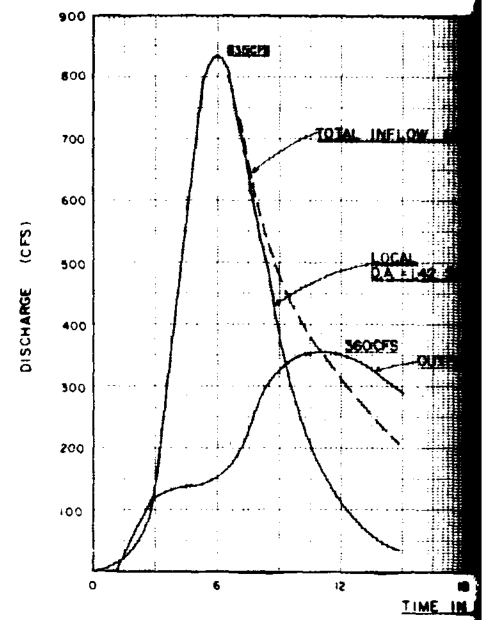
MARCH 1968 FLOOD
ANALYSIS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

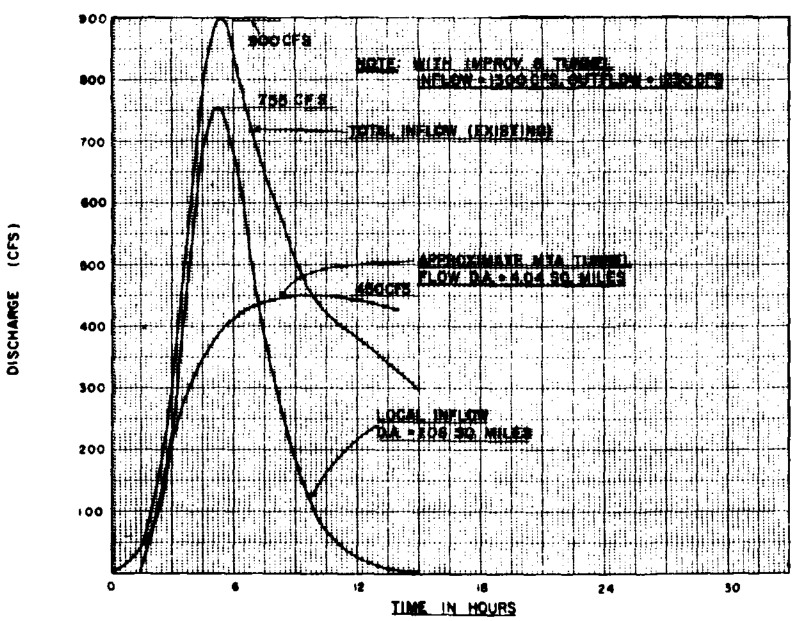
PLATE 6



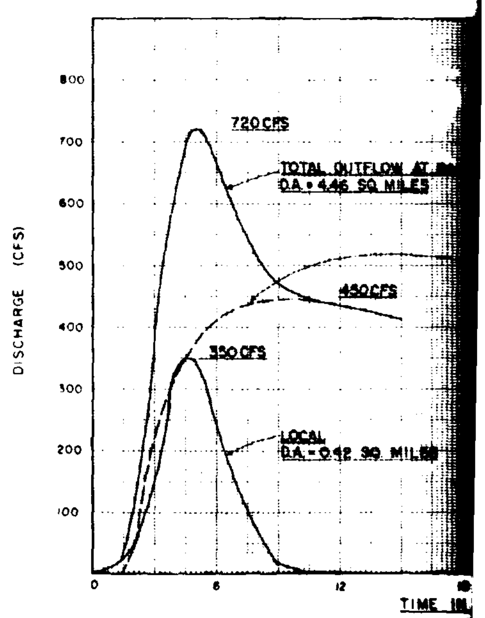
QUINCY RESERVOIR
D.A. = 1.56 SQ MILES



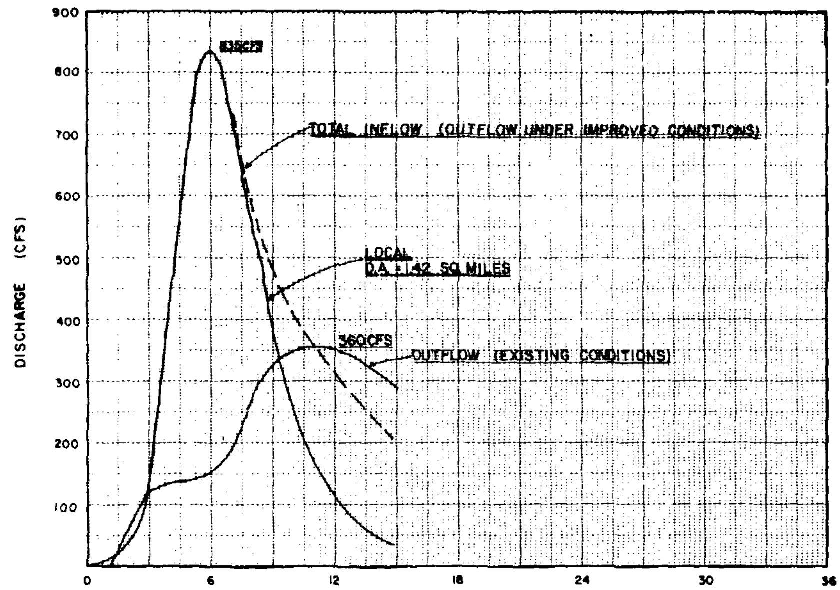
CENTRE
DA = 2.98



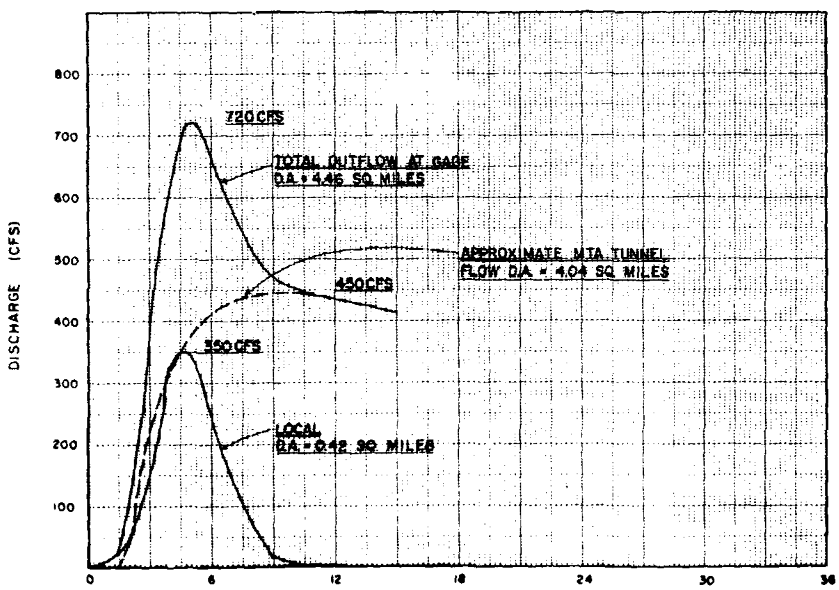
BROOK ROAD TO
M.T.A. TUNNEL ENTRANCE
D.A. = 4.04 SQ MILES



USGS GA
BIGELOW
DA = 4.46



CENTRE STREET
D.A. = 2.98 SQ. MILES



USGS GAGE NEAR
BIGELOW STREET
D.A. = 4.46 SQ MILES

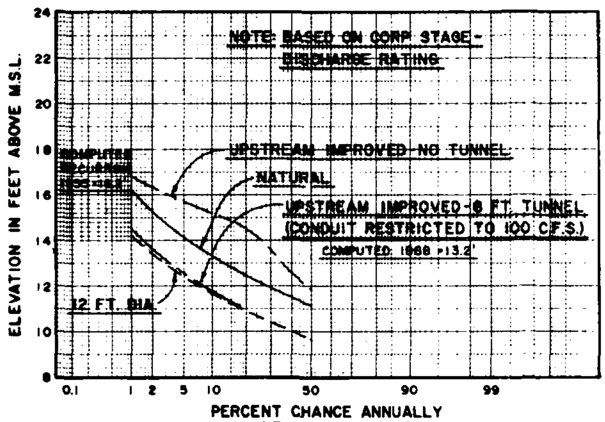
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

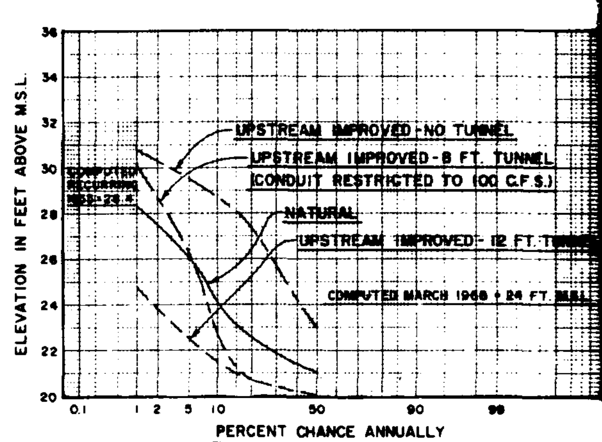
AUGUST 1955 FLOOD
ANALYSIS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

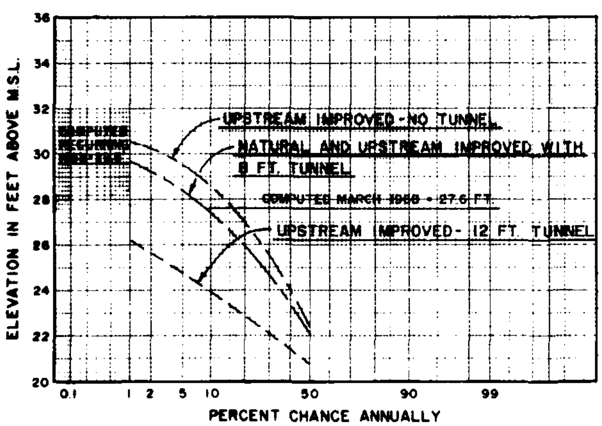
PLATE 7



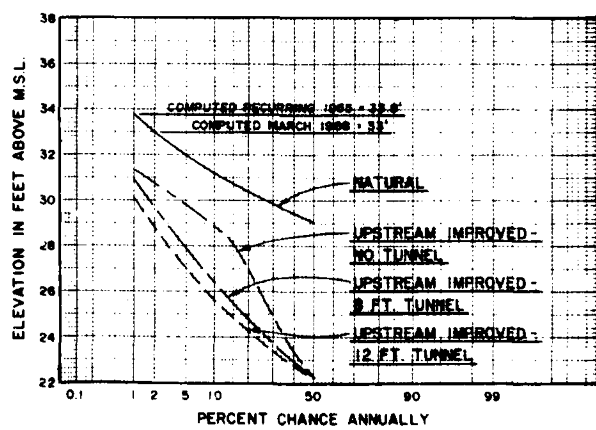
BIGELOW STREET
USGS GAGE
INDEX STA. #2
D.A. = 4.46 SQ. MILES



M.T.A. CONDUIT ENTRANCE
INDEX STA. #2A
D.A. = 4.04 SQ. MILES

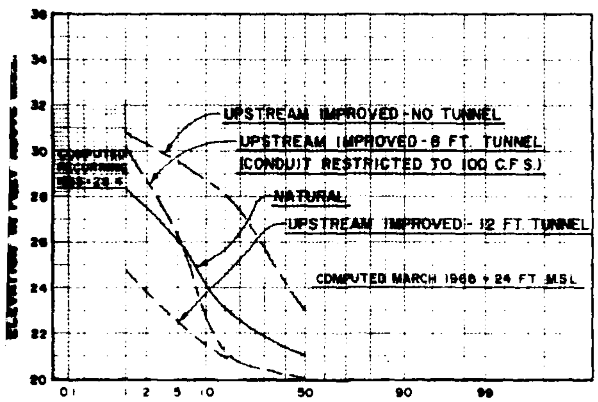


BROOK ROAD
INDEX STA. #3

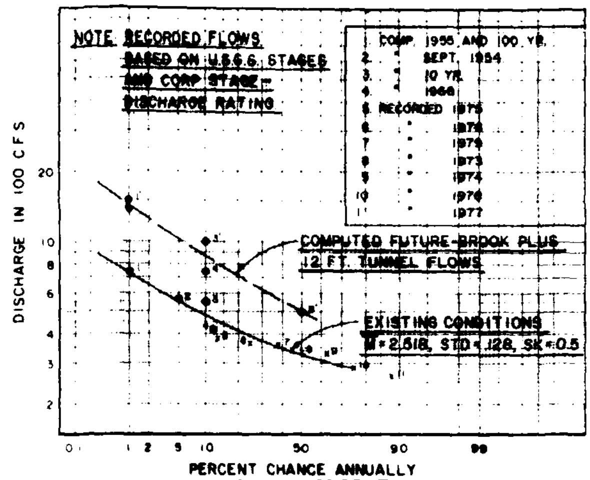


CENTRE STREET
INDEX STA. #4
D.A. = 2.98 SQ. MILES

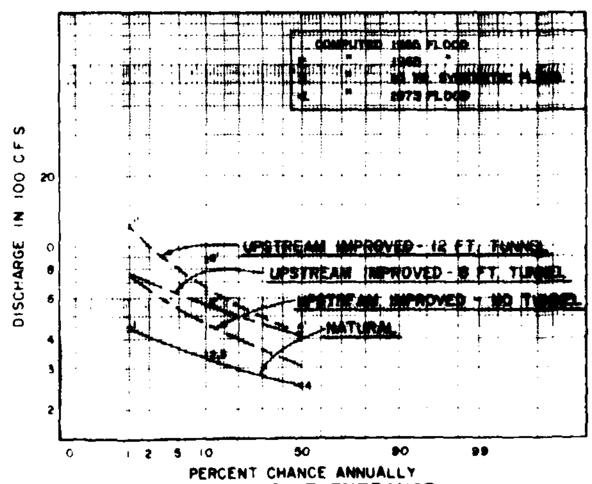
D E F G H U. S. ARMY



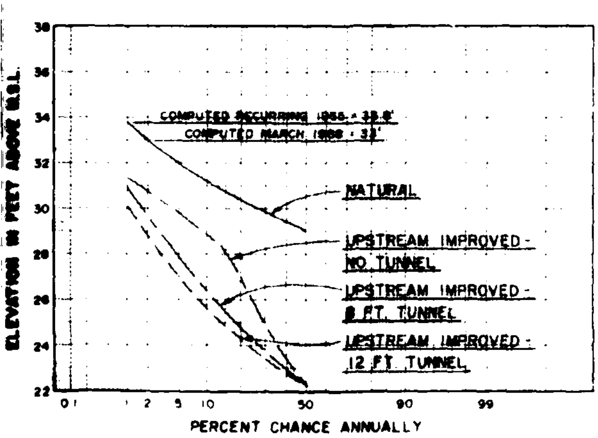
M.T.A. CONDUIT ENTRANCE
INDEX STA # 2A
DA = 4.04 SQ. MILES



BIGELOW STREET
USGS GAGE
INDEX STA # 2
D.A. = 4.46 SQ. MILES



M.T.A. CONDUIT ENTRANCE
INDEX STA # 2A
DA = 4.04 SQ. MILES



CENTRE STREET
INDEX STA # 4
DA = 2.98 SQ. MILES

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

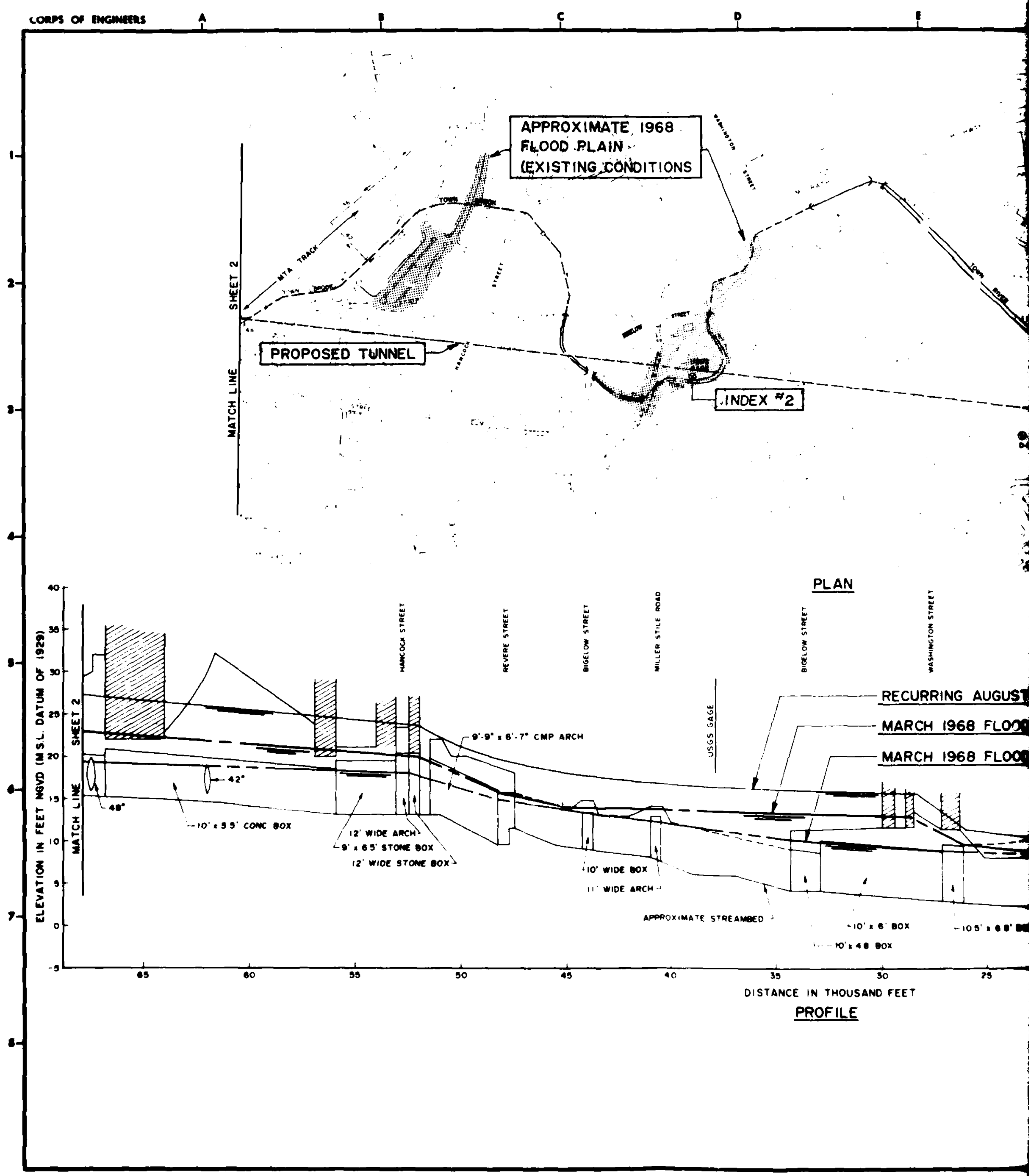
TOWN BROOK QUINCY, MASSACHUSETTS

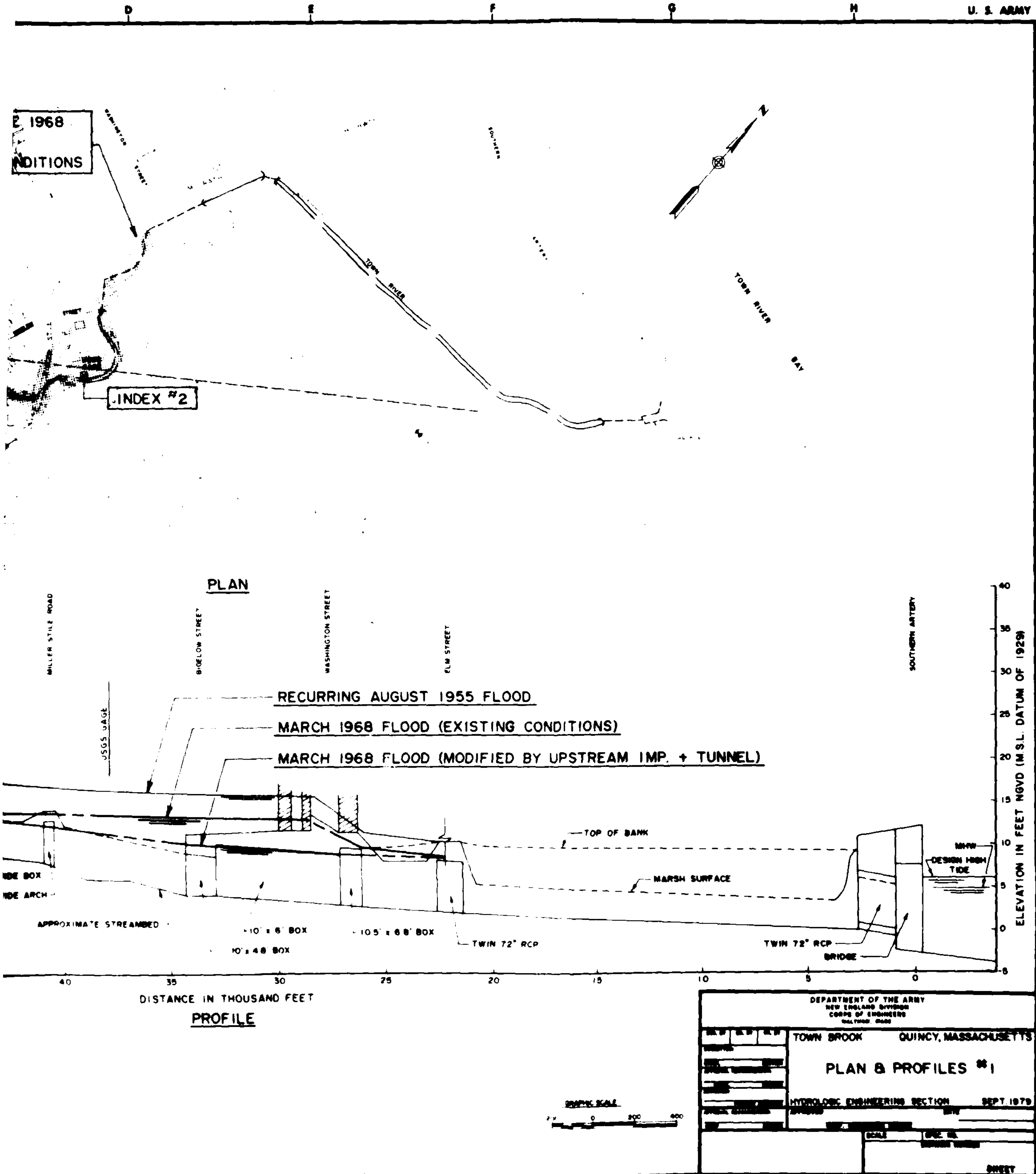
DISCHARGE & STAGE
FREQUENCY CURVES

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

PLATE 8

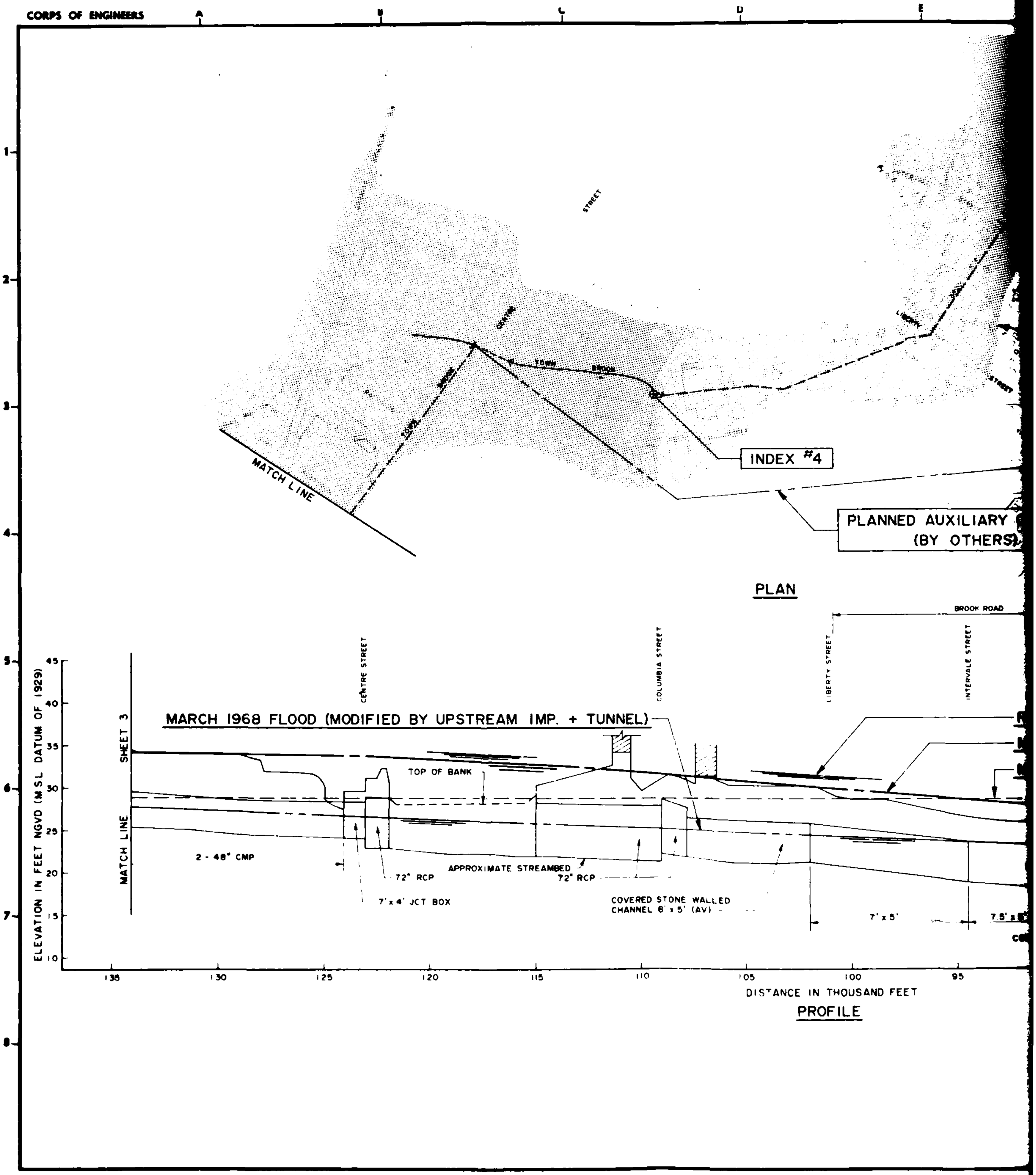
CORPS OF ENGINEERS



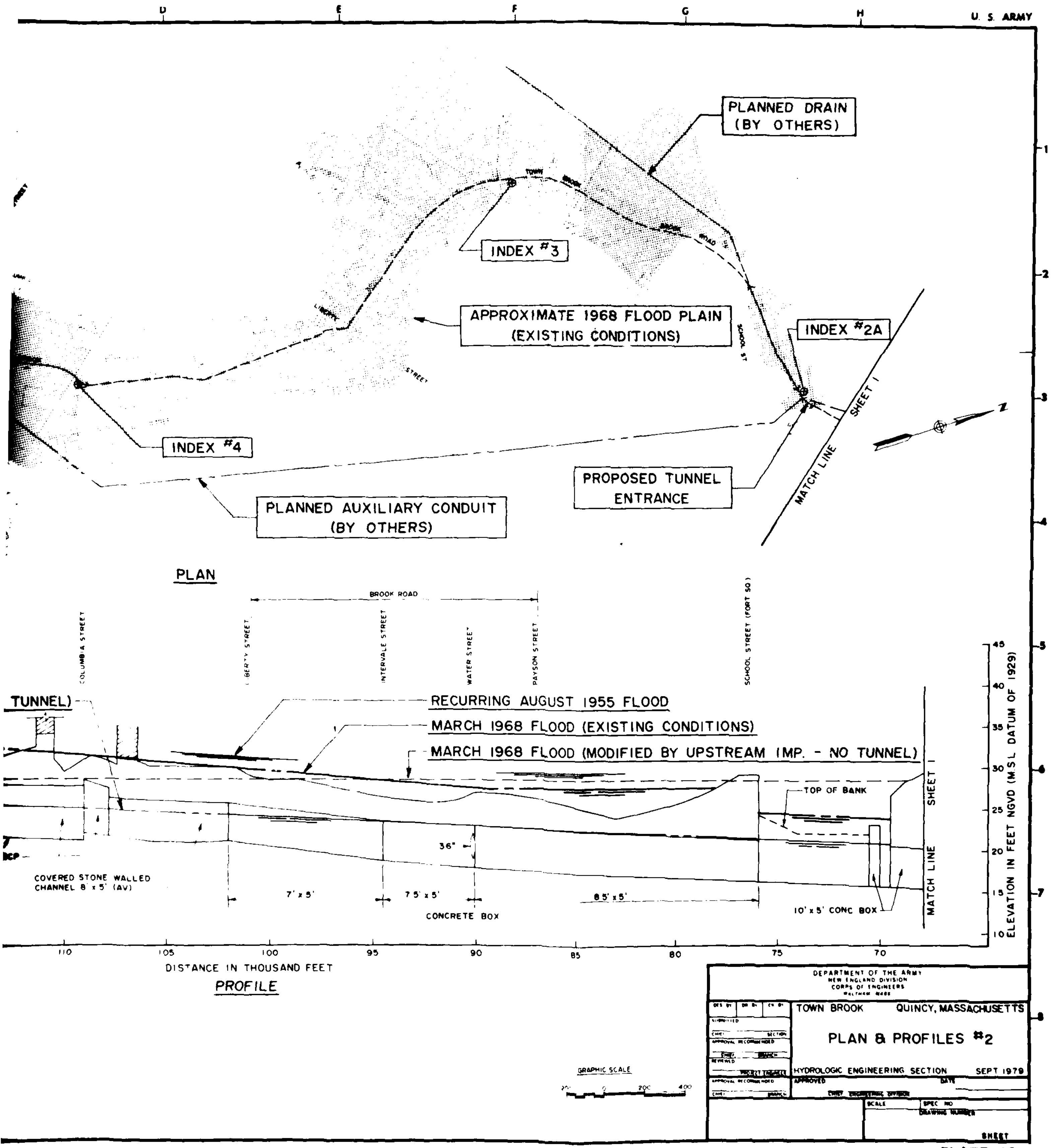


U. S. ARMY
D
E
F
G
H
E 1968
NDITIONS
INDEX #2
TOWN RIVER
TOWN RIVER BAY
N
PLAN
MILLER STILE ROAD
BIGELOW STREET
WASHINGTON STREET
ELM STREET
SOUTHERN ARTERY
USGS GAGE
RECURRING AUGUST 1955 FLOOD
MARCH 1968 FLOOD (EXISTING CONDITIONS)
MARCH 1968 FLOOD (MODIFIED BY UPSTREAM IMP. + TUNNEL)
TOP OF BANK
MARSH SURFACE
MHW
DESIGN HIGH TIDE
APPROXIMATE STREAMBED
10' x 6' BOX
10.5' x 6.8' BOX
10' x 4.8' BOX
TWIN 72" RCP
BRIDGE
ELEVATION IN FEET NGVD (M.S.L. DATUM OF 1929)
DISTANCE IN THOUSAND FEET
PROFILE
GRAPHIC SCALE
DEPARTMENT OF THE ARMY
TOWN BROOK
QUINCY, MASSACHUSETTS
PLAN & PROFILES #1
HYDROLOGIC ENGINEERING SECTION
SEPT. 1979

PLATE 9

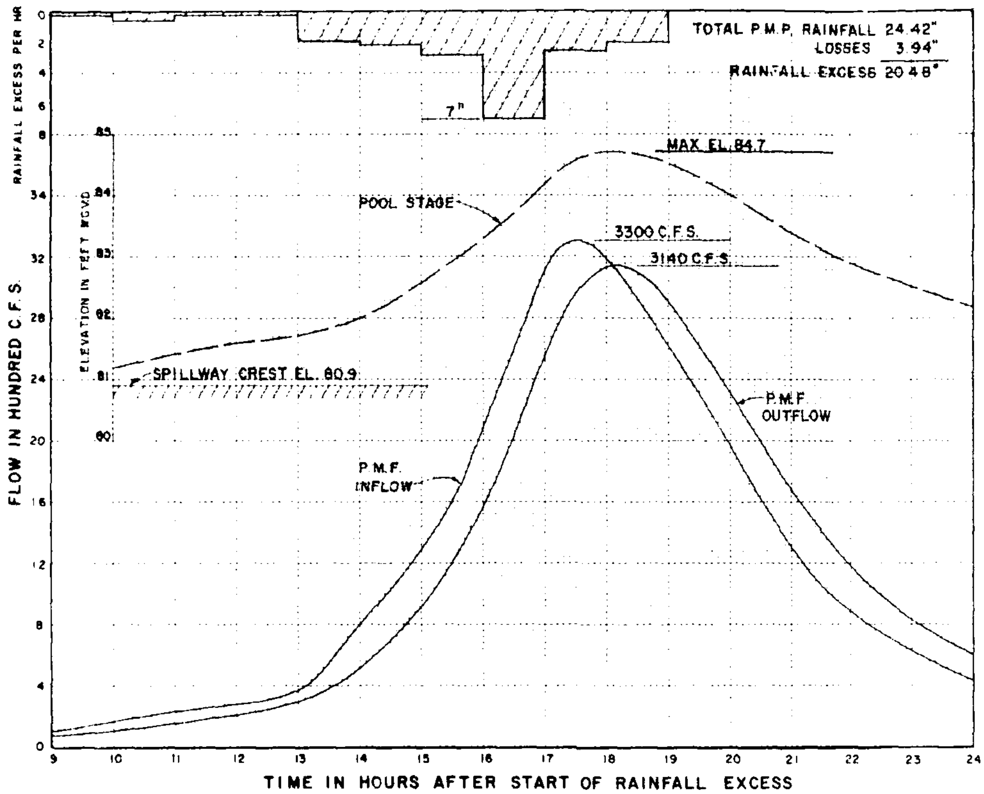


CORPS OF ENGINEERS
STREET
INDEX #4
PLANNED AUXILIARY
(BY OTHERS)
MATCH LINE
PLAN
BROOK ROAD
CENTRE STREET
COLUMBIA STREET
LIBERTY STREET
INTERVALE STREET
MARCH 1968 FLOOD (MODIFIED BY UPSTREAM IMP. + TUNNEL)
SHEET 3
MATCH LINE
TOP OF BANK
2 - 48" CMP
72" RCP
7' x 4' JCT BOX
APPROXIMATE STREAMBED
COVERED STONE WALLED
CHANNEL 8' x 5' (AV)
7' x 5'
ELEVATION IN FEET NGVD (M.S.L. DATUM OF 1929)
DISTANCE IN THOUSAND FEET
PROFILE

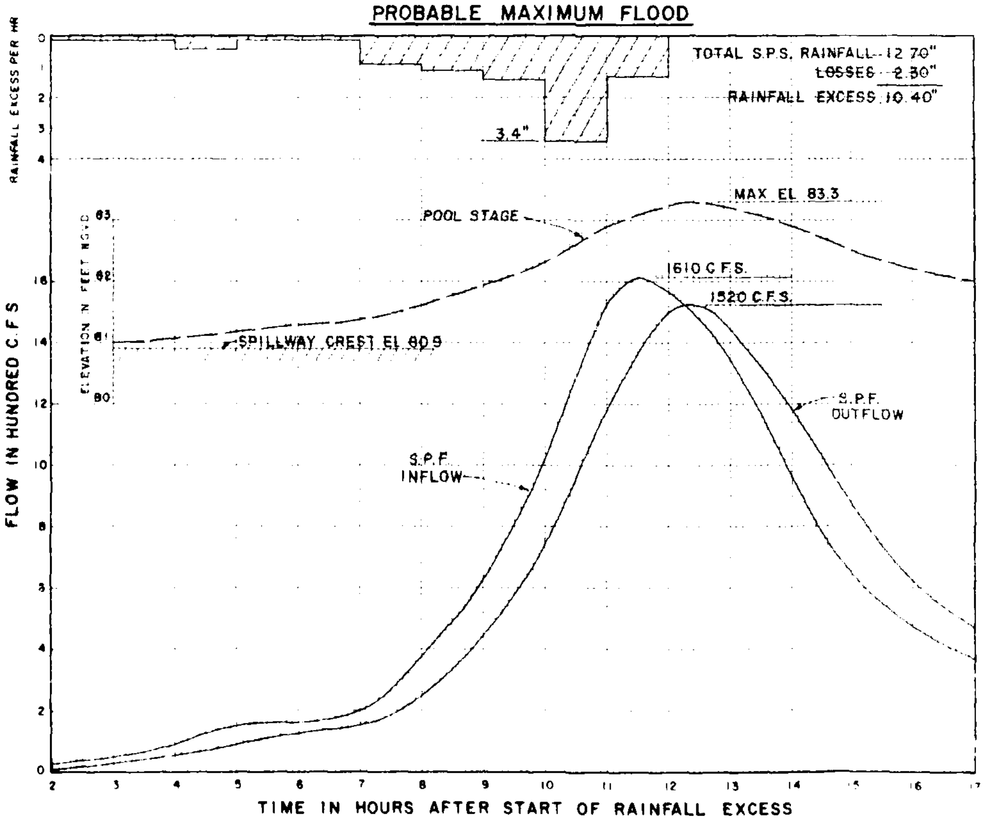


U. S. ARMY
PLANNED DRAIN (BY OTHERS)
INDEX #3
APPROXIMATE 1968 FLOOD PLAIN (EXISTING CONDITIONS)
INDEX #2A
INDEX #4
PROPOSED TUNNEL ENTRANCE
PLANNED AUXILIARY CONDUIT (BY OTHERS)
MATCH LINE SHEET 1
PLAN
BROOK ROAD
COLUMBIA STREET
INTERVALE STREET
WATER STREET
PAYSON STREET
SCHOOL STREET (FORT SQ)
TUNNEL)
RECURRING AUGUST 1955 FLOOD
MARCH 1968 FLOOD (EXISTING CONDITIONS)
MARCH 1968 FLOOD (MODIFIED BY UPSTREAM IMP. - NO TUNNEL)
TOP OF BANK
MATCH LINE SHEET 1
36"
COVERED STONE WALLED CHANNEL 8' x 5' (AV)
7' x 5'
7.5' x 5'
8.5' x 5'
CONCRETE BOX
10' x 5' CONC BOX
ELEVATION IN FEET NGVD (M.S.L. DATUM OF 1929)
DISTANCE IN THOUSAND FEET
PROFILE
GRAPHIC SCALE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
TOWN BROOK QUINCY, MASSACHUSETTS
PLAN & PROFILES #2
HYDROLOGIC ENGINEERING SECTION SEPT 1979

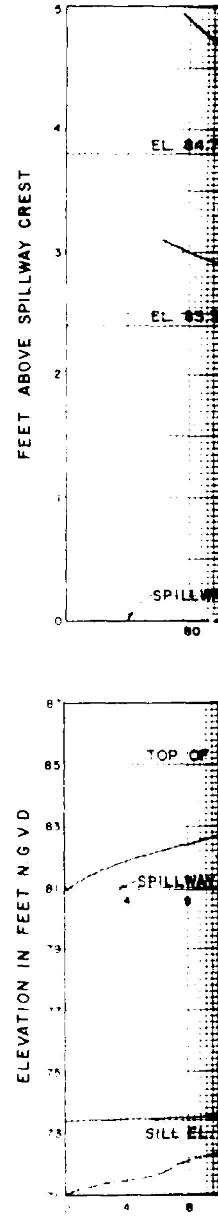
PLATE 10



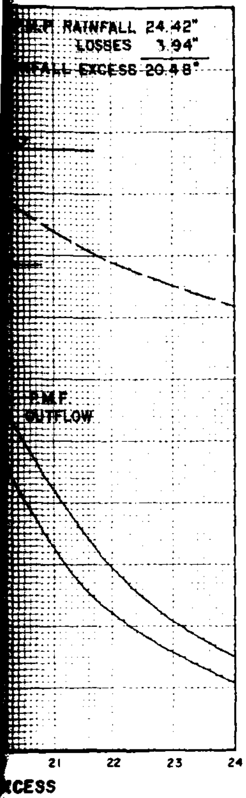
PROBABLE MAXIMUM FLOOD

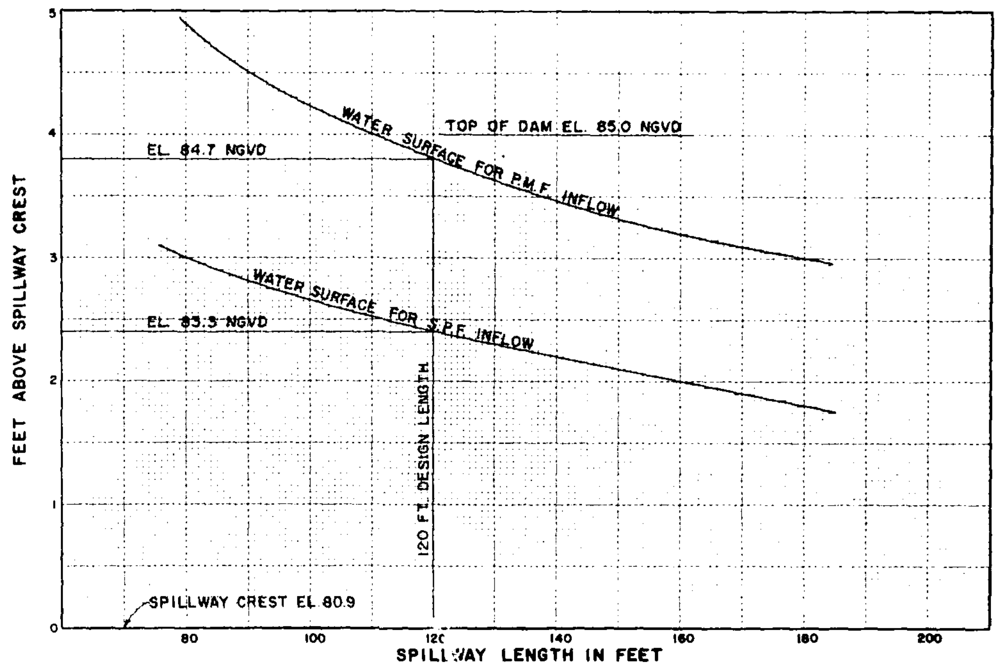


STANDARD PROJECT FLOOD

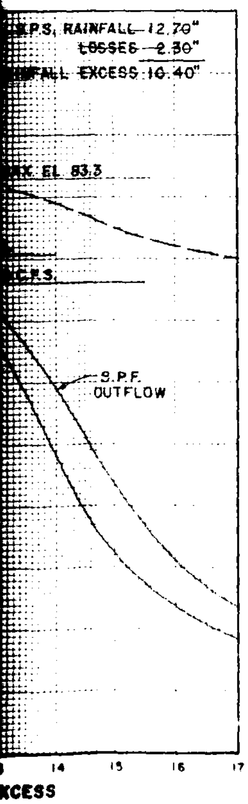


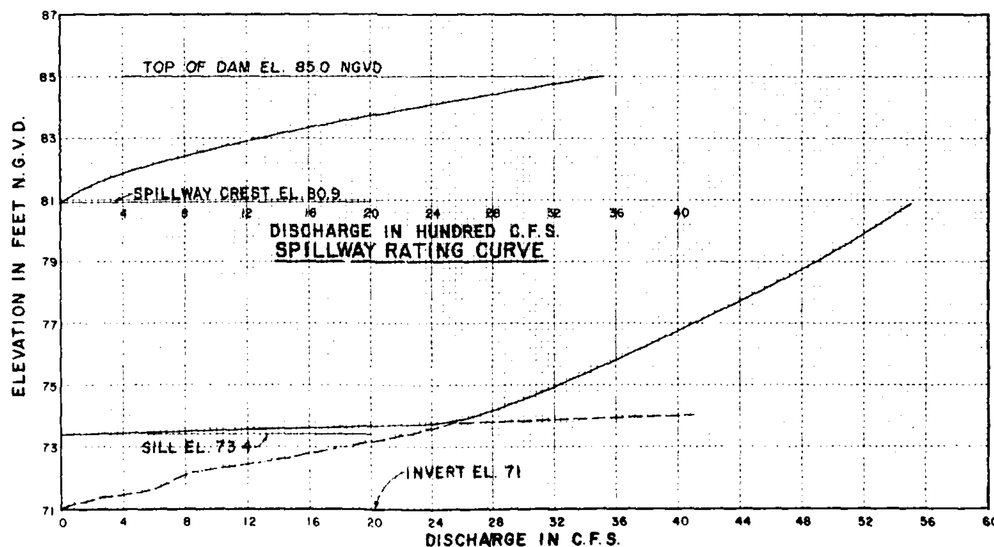
D E F G H U. S ARMY





SPILLWAY LENGTH-SURCHARGE CURVES





INLET RATING CURVE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

QUINCY RESERVOIR
SPILLWAY DESIGN

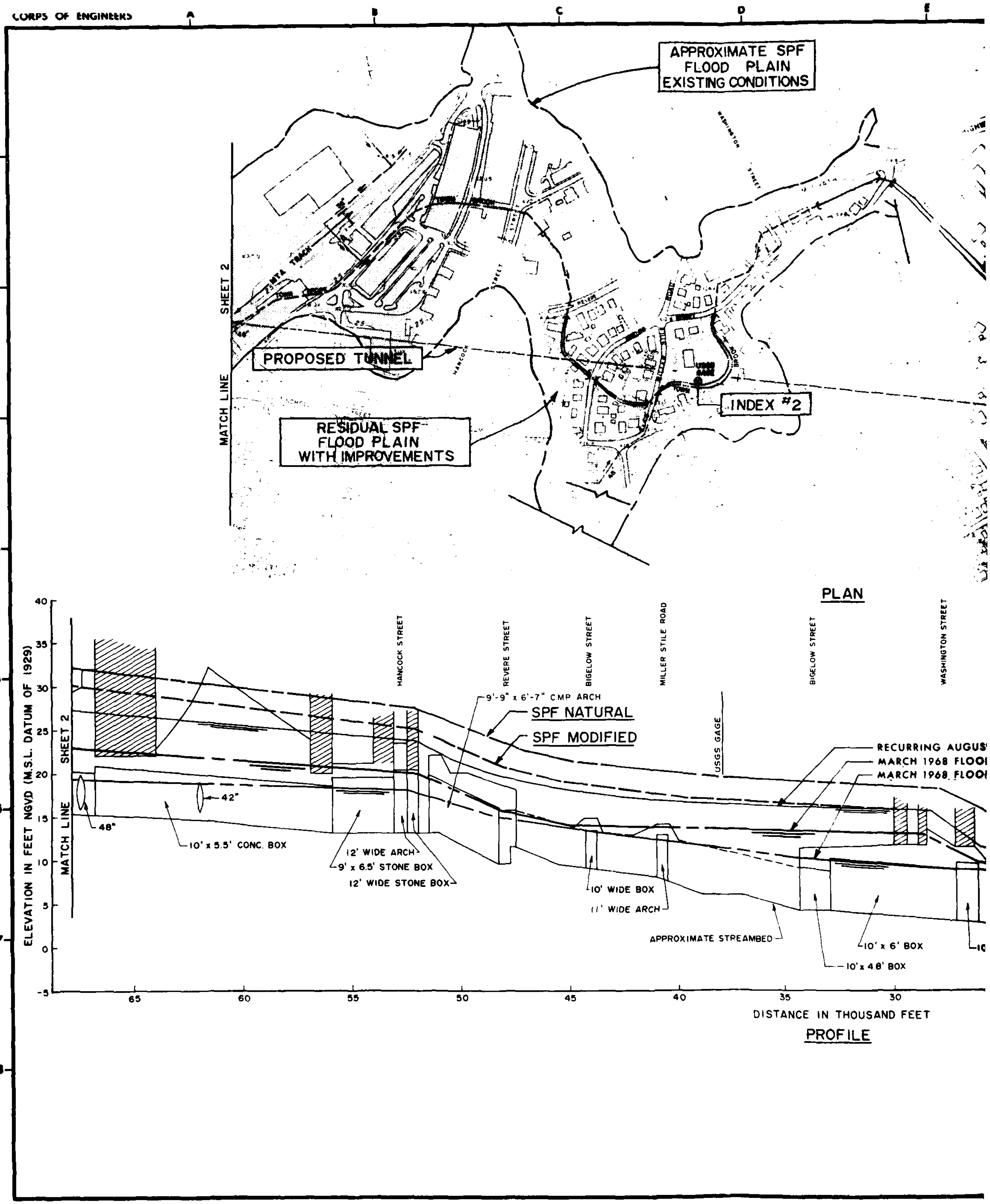
HYDROLOGIC ENG SECT APRIL 1980

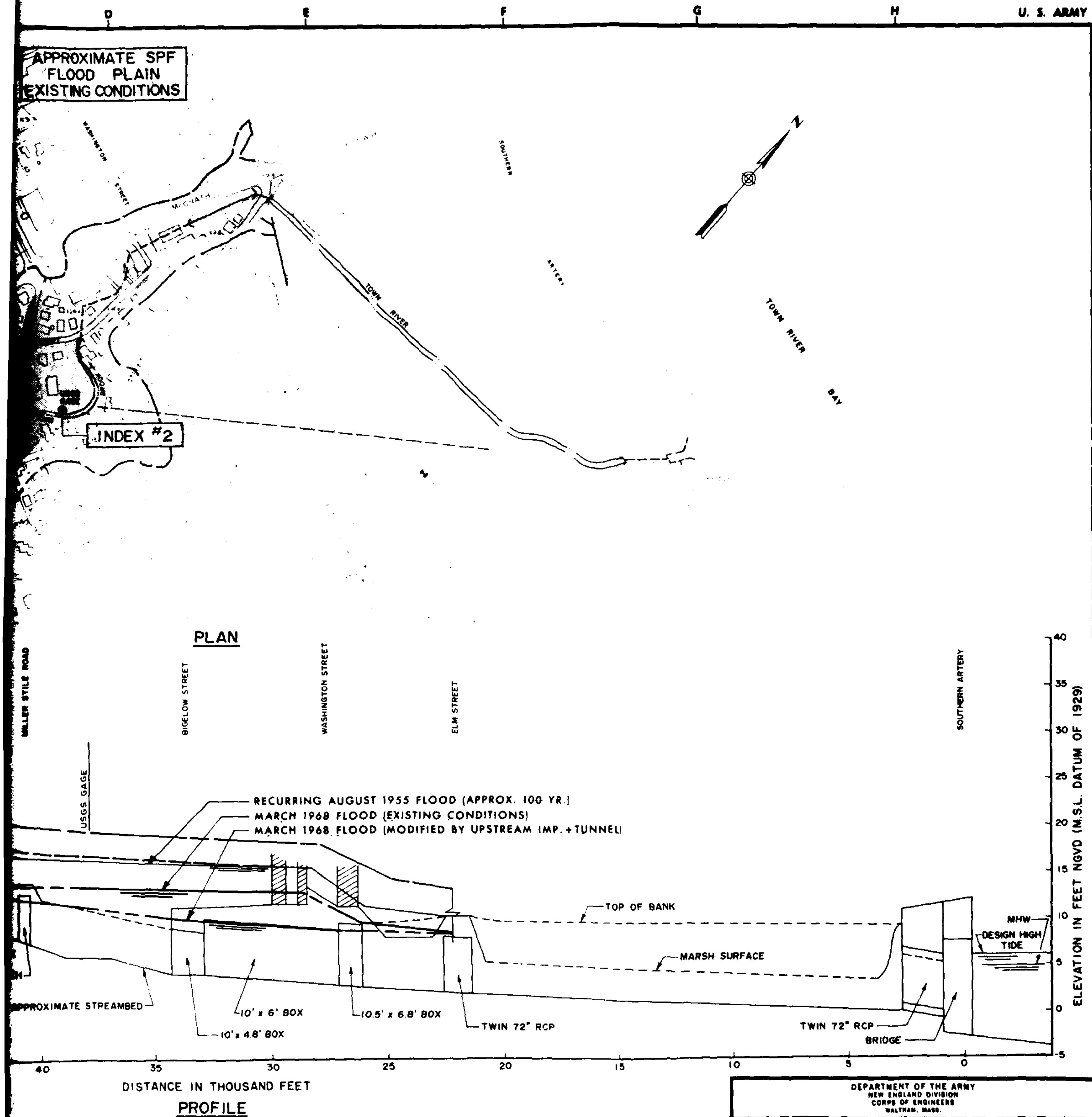
SUBMITTED
CHIEF SECTION
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
REVIEWED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF BRANCH
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE SPEC NO
DRAWING NUMBER
SHEET

PLATE 11

2

CORPS OF ENGINEERS





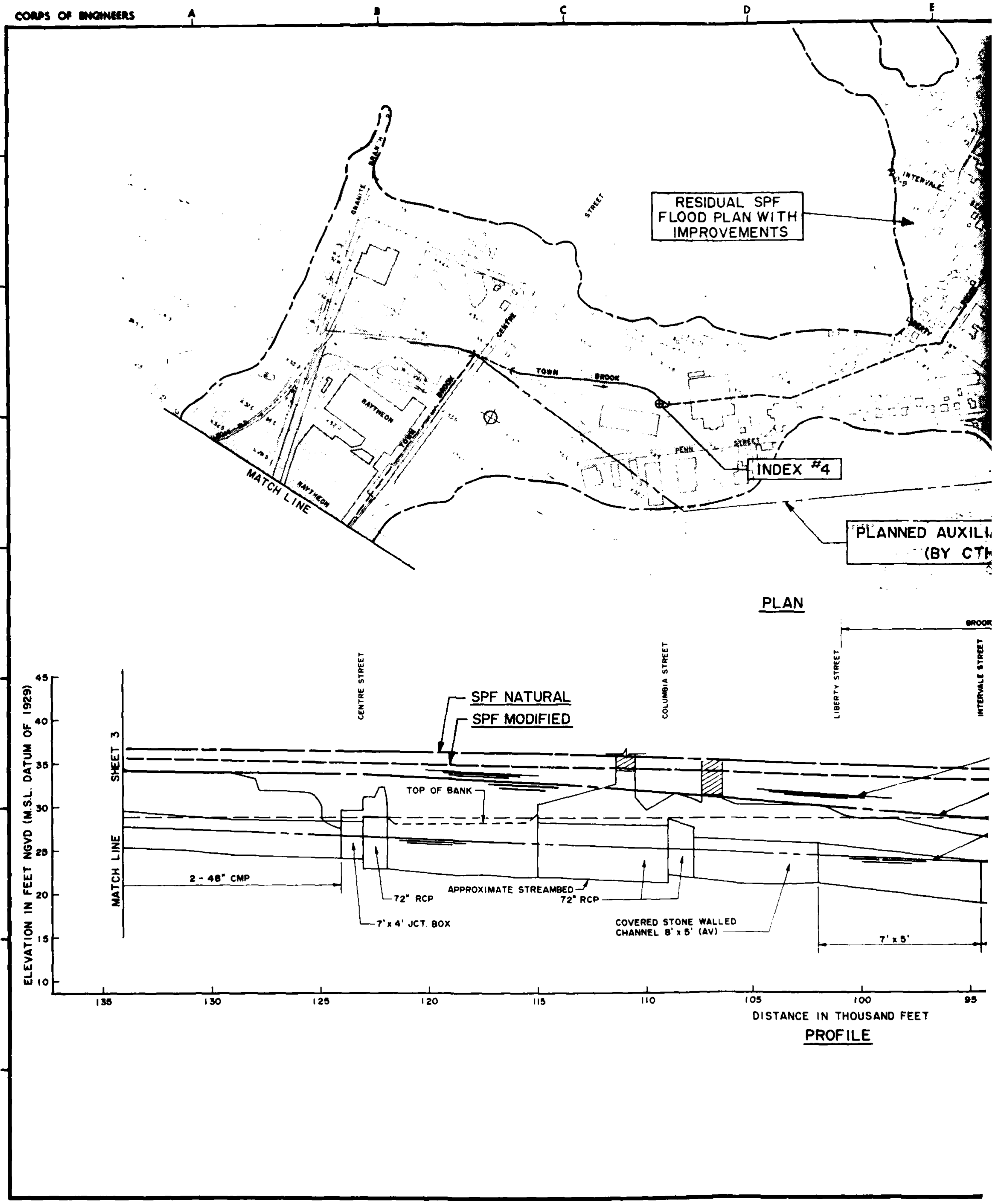
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS
STANDARD PROJECT FLOOD
PLAN & PROFILES #1
(APPROXIMATE)

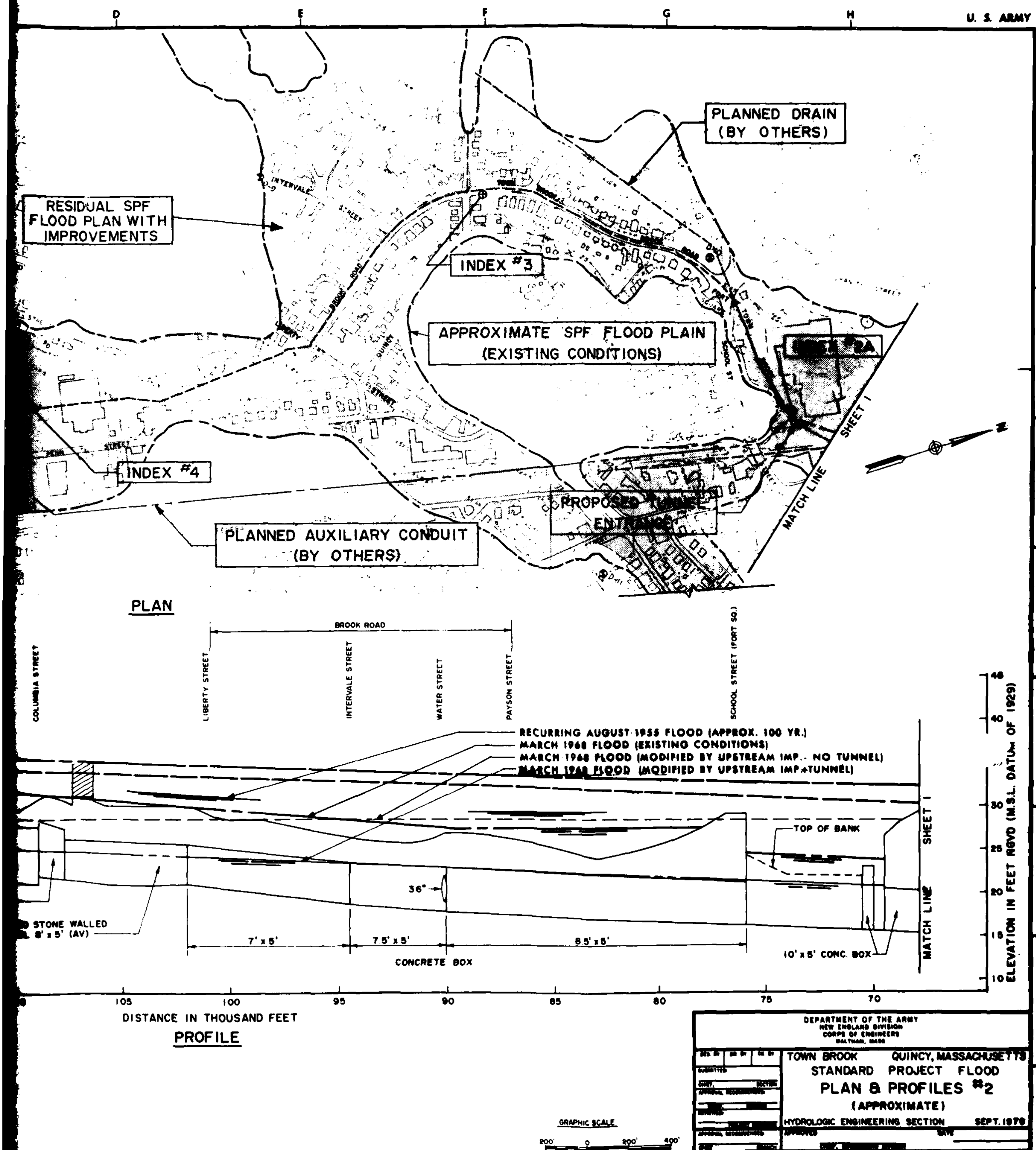
HYDROLOGIC ENGINEERING SECTION SEPT. 1979

PLATE 12

2



CORPS OF ENGINEERS
A
B
C
D
E
1
2
3
4
5
6
7
8
RESIDUAL SPF
FLOOD PLAN WITH
IMPROVEMENTS
INDEX #4
PLANNED AUXILI
(BY CT
MATCH LINE
RAYTHEON
TOWN BROOK
CENTRE
GRANITE
PENN STREET
STREET
INTERVALE
PLAN
CENTRE STREET
COLUMBIA STREET
LIBERTY STREET
INTERVALE STREET
SPF NATURAL
SPF MODIFIED
SHEET 3
MATCH LINE
TOP OF BANK
2 - 48" CMP
72" RCP
7' x 4' JCT. BOX
APPROXIMATE STREAMBED
72" RCP
COVERED STONE WALLED
CHANNEL 8' x 5' (AV)
7' x 5'
ELEVATION IN FEET NGVD (M.S.L. DATUM OF 1929)
45
40
35
30
25
20
15
10
135
130
125
120
115
110
105
100
95
DISTANCE IN THOUSAND FEET
PROFILE



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS
STANDARD PROJECT FLOOD
PLAN & PROFILES #2
(APPROXIMATE)

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

PLATE 13

2

TOWN BROOK
QUINCY, MASSACHUSETTS

APPENDIX D

CHAPTER II
WATER QUALITY EVALUATION

BY
HYDRAULICS AND WATER QUALITY SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

JUNE 1980

CHAPTER II

WATER QUALITY EVALUATION
TOWN BROOK
QUINCY, MASSACHUSETTS

TABLE OF CONTENTS

Paragraph	Subject	Page
1	Existing Water Quality Conditions	1
2	Water Quality Related Impacts	3
3	Future Studies	6

LIST OF TABLES

Table	Title	Page
I	Massachusetts Water Quality Standards	2

LIST OF PLATES

Plate	Title	Page
1	Tunnel and Circulation Pipe	

TOWN BROOK

WATER QUALITY EVALUATION

1. EXISTING WATER QUALITY CONDITIONS

Town Brook and Town River have been assigned objective water quality classifications of Class B and Class SB by the Massachusetts Water Resources Commission. Class B standards apply to the inland waters of the streams, and Class SB standards apply to the marine waters. Both Class B and SB waters are suitable for the propagation and protection of fish, wildlife and aquatic life and for primary and secondary recreation; Class SB waters also support shellfish harvesting with depuration (natural cleaning process). Specific criteria applicable to B and SB waters are presented on Table 1.

Very little water quality data is available for Town Brook and Town River. The Massachusetts Divison of Water Pollution Control conducted an intensive survey in the summer of 1975 that included one station on Town Brook at the outlet of Old Quincy Reservoir and one station on Town River at the Route 3A bridge. Data was collected at four stations on Town Brook on one day each in September and October 1974 by an environmental consulting firm, and the Metropolitan District Commission collected some data at 14 stations along the brook on one day in January 1975. Lastly, the U.S. Geological Survey has taken several readings of water temperature and conductivity at the gaging station on Town Brook since 1974.

Based on the available scant data base, water quality conditions in Town Brook and Town River may be expected to marginally meet the requirements for Class B and SB waters. Organic contamination of some kind is evident in the data with BOD_5 concentrations ranging up to 20 mg/l and total kjeldahl nitrogen ranging from 0.6 to 8.7 mg/l. Chloride levels are high, indicating that road deicing materials and/or contaminants of human origin are entering the streams; and the pH is low with values commonly less than 6.5. Conductivity data is high, and, correspondingly, total dissolved solids levels are high. All recorded dissolved oxygen concentrations were above the Class B standard minimum allowable concentrations of 5.0 mg/l.

Town Brook and Town River are located in a very heavily urbanized area of eastern Massachusetts. As such, conditions in the streams are probably greatly influenced by man's activities, particularly through point and nonpoint sources of pollution. Urban stormwater runoff has the potential for seriously degrading water quality by introducing a myriad of contaminants such as oils, grease, lead, organic and inorganic solids and nutrients. The susceptibility to contamination is clear and the effects must be fully understood in relation to any development of the water resource.

TABLE I

MASSACHUSETTS WATER QUALITY STANDARDS

CLASS B AND CLASS SB WATERS

	CLASS B	CLASS SB
Dissolved Oxygen	5.0 mg/l	6.0 mg/l
Temperature	83° F. and maximum rise resulting from artificial origin shall not exceed 4° Fahrenheit	No increase that will exceed recommended limits for the most sensitive water use
pH	6.5 to 8.0 and not more than 0.2 units outside of naturally occurring range	6.5 to 8.5 and not more than 0.2 units outside of naturally occurring range
Fecal Coliform Bacteria	Log mean of 200 per 100 ml nor shall more than 10% of total samples during any monthly period exceed 400 per 100 ml	No Standard
Total Coliform Bacteria	No Standard	Median value of 700 MPN per 100 ml nor shall more than 20% of total sample during any monthly period exceed 1000 MPN per 100 ml

Criteria applicable to both classes: Good aesthetic value and appearance; nutrients not to exceed limits necessary to control eutrophication; radioactive substances not to exceed drinking water criteria; other constituents not in concentrations that exceed applicable criteria for the most sensitive water uses.

2. WATER QUALITY RELATED IMPACTS

a. Introduction. The proposed plan of Federal action includes structural modifications at Old Quincy Reservoir and a diversion tunnel under downtown Quincy. Work at the reservoir would include a new intake structure that would allow regulation of the lake level, construction of a dike along the northern shore of the reservoir and a new emergency spillway. The diversion tunnel would be constructed in deep rock and would run from the vicinity of School Street, Quincy to a point on the Town River just upstream from Route 3A. Potential areas of impact on water quality conditions will be at the new intake structure at the reservoir and within and downstream from the diversion tunnel.

b. Old Quincy Reservoir. With the existing intake structure at Old Quincy Reservoir, water is withdrawn from the bottom of the lake and discharged downstream through a culvert. The proposed modification would consist of a weir structure that would maintain the pool level at approximately elevation 73.4 Withdrawal would be from the surface of the reservoir and, consequently, the temperature of the water discharged downstream could be slightly warmer than that currently existing. The magnitude of the change in discharge temperature will be a function of the degree of temperature stratification in the reservoir, the discharge rate, the weir configuration and other physical, hydrological and meteorological variables. Since the reservoir is relatively shallow, about 20 to 25 feet deep, strong stratification is not expected to exist; however, temperature differences from top to bottom of 10° F. to 15° F. are likely. This would also represent the maximum change in discharge temperatures over present conditions. The altered temperature regime would exist for some distance downstream until the stream attains an equilibrium condition with the environment. Since all outflows would be skimmed from the surface, it is possible that the temperature regime within the reservoir itself could also be altered through creation and maintenance of a zone of slightly cooler water at the bottom.

c. Diversion Tunnel. The effect of the proposed diversion tunnel on receiving water quality will range from negligible to severe, depending on the quality of the water which discharges from the tunnel. If the tunnel's contents stay aerobic, the water discharged from the tunnel will be very similar to that which entered the tunnel. A small decrease in dissolved oxygen (DO) might occur along with a reduction in the level of coliform bacteria present. The DO would be replenished through aeration at the tunnel discharge and mixing with aerated seawater. If the tunnel's contents turn anaerobic, however, severe problems including the generation of septic odors and hydrogen sulfide gas might occur.

Whether or not the tunnel's contents turn anaerobic depends on three things: (1) the quality of the water entering the tunnel, (2) the length of time the water is impounded in the tunnel and, (3) the amount of mixing or aeration that occurs in the tunnel.

Two types of water will be entering this tunnel from opposite directions. Storm water runoff with varying characteristics will flow into the entrance; and seawater, with more uniform characteristics, will be entering through the outlet by tailwater submergence at each semi-diurnal high tide.

The quality of the storm water runoff from an urban watershed such as Town Brook will depend on the intensity and duration of the storm, the intervening time since the last storm, and other factors such as the frequency of street cleaning. The worst water quality would come from a short-duration, high-intensity storm after a long dry period with no street sweeping. The water entering the tunnel under these conditions would have high levels of biochemical oxygen demand (BOD), suspended and dissolved solids, and metals. A long-duration storm following closely on another storm in an area where the streets are swept regularly would leave relatively clean water in the tunnel.

Seawater will enter the tunnel twice a day if the invert of the outlet is below mean high tide level and no means of keeping the seawater out are installed. The heavier seawater will flow down the tunnel exit shaft either mixing with or displacing the lighter freshwater until the outlet shaft and at least part of the tunnel are full of seawater.

When water with high levels of BOD is impounded in a closed system, the DO will soon be depleted, creating anaerobic conditions. Under these conditions, septic odors, hydrogen sulfide and methane gas are produced and iron and manganese are converted to soluble forms. The methane gas will not be a problem unless there are poorly vented storm drain inlets connected to this tunnel. Methane gas in these could accumulate to explosive levels. Septic odors and hydrogen sulfide gas could be problems at the tunnel entrance and exit and any other connections made to the tunnel. Under anaerobic conditions iron and manganese are converted to soluble forms. Upon release to the aerobic environment these elements revert back to the nonsoluble form and could cause staining of the concrete at the tunnel outlet.

Seawater entering the tunnel will displace some of this low DO storm water runoff. However, not all the oxygen-demanding debris washed into the tunnel by the storm will be removed by the gentle displacing action of seawater. These residual solids and the mixing with the low DO storm water and the seawater's own BOD will cause a continuation of anaerobic conditions.

Anaerobic conditions involving seawater are worse than anaerobic conditions involving storm water because the high sulfate levels in seawater will allow for the generation of much more hydrogen sulfide gas. The problems caused by hydrogen sulfide gas are foul odors, the blackening of lead-based house paints, the deterioration of concrete, and the poisoning of aquatic life.

The unpleasant, rotten-egg odor of hydrogen sulfide gas is well known. It may occur in noticeable amounts at the tunnel outlet and at any connections made to the tunnel. However, it will occur in very unpleasant

concentrations when a runoff event forces stagnant tunnel water up to the surface. The reduction in hydrostatic pressure that occurs then will allow dissolved hydrogen sulfide gas to be released at a high rate. If prevailing winds carry this gas towards buildings it can cause a blackening of certain types of house paint in addition to severe odor problems.

Concrete is not corroded by hydrogen sulfide gas. However, if this gas is released to the atmosphere near concrete, which is wet from condensation, the hydrogen sulfide can be absorbed into the moisture. Under aerobic conditions, oxidizing bacteria will convert the dissolved hydrogen sulfide gas to sulfuric acid which is very corrosive to concrete. This series of events would be most likely to occur in connection shafts to the main tunnel and to a lesser extent at the entrance and outlet shafts.

Dissolved hydrogen sulfide gas is poisonous to aquatic life. The anaerobic waters discharged from the tunnel during a runoff event will be lethal to most aquatic fauna. Aeration at the tunnel outlet and mixing with oxygenated seawater may raise the DO to acceptable levels but still leave hydrogen sulfide at harmful concentrations.

The prevention of anaerobic conditions in the tunnel can be accomplished by flushing the tunnel, mechanically aerating the tunnel, oxygen injection or pumping the tunnel dry between runoff events.

Flushing the tunnel could be done with freshwater or seawater. A small constant stream of clean freshwater introduced at the tunnel's entrance might be enough to maintain aerobic conditions in the tunnel. It is also possible, however, that density stratification would occur and the freshwater would flow, without mixing, over the more dense anaerobic saltwater in the bottom of the tunnel. A second method of flushing with freshwater would involve regular introductions of a large volume of water at a high rate into the tunnel entrance. This might flush the tunnel clean, but it also might flow over the seawater without mixing.

Flushing the tunnel with seawater could be accomplished using the head differential between high and low tides, and a bleed-off line. This line would be connected to the tunnel invert and would discharge 5 to 6 feet lower than the tunnel outlet. High tides would submerge both of these, but low tides will cause a flow from the impounded water in the outlet shaft out through the bleed-off line. However, short circuiting of the path of the seawater may cause insufficient mixing in the tunnel. Mechanical mixing might be required to supplement flushing with either fresh or saltwater.

Aeration of the tunnel contents would prevent anaerobic conditions provided that the aeration breaks up any stratification patterns in the tunnel. The aeration should be nearly continuous, however, for if anaerobic conditions develop and the tunnel's contents are then aerated, the aeration will bring septic odors and hydrogen sulfide to the surface. A problem with aerating a deep tunnel is nitrogen gas supersaturation. When a runoff event forces the tunnel water to the surface, the rapid release of the hydrostatic

pressure will cause dissolved gases to come rapidly out of solution. This could cause "gas bubble disease" in fish in the receiving water.

The injection of pure oxygen through some means of diffusion is another alternative solution to the anaerobic problem.

Pumping the tunnel dry between runoff events would prevent anaerobic conditions from developing. In this case, facilities would have to be provided at the outlet to prevent seawater from intruding into the tunnel.

Preliminary investigations have indicated that flushing the tunnel with saltwater is the most practical option and can be accomplished by incorporating a circulation pipe in the tunnel which will discharge in Town River Bay (see Plate 1). This system would take maximum advantage of the normal 9.5-foot tide range (4.8 feet MHW to -4.7 feet MLW) by allowing the approximately 48,000 cubic feet of water trapped in the tunnel outlet structure below elevation +2 to move upstream into the tunnel in plug flow form during each tide cycle. With this volume of flush-water, the theoretical time for complete exchange is about five days, which should be sufficient to prevent nuisance conditions from developing. The intake to the circulation pipe would be at the upstream end of the tunnel in order to prevent short-circuiting of the flow. The outlet would be located such that the crown of the pipe would be at mean low water elevation. A flap gate hinged at the top would be required at the outlet to prevent saltwater from flowing back into the tunnel during flood tide.

The success of the circulation system will depend on minimizing the head losses through the system. For the average circulation flow of 3.2 cfs, a 2.5-foot diameter concrete pipe will result in a total friction loss of approximately 0.5 foot, which, because of the small head available, is the maximum tolerable. All other losses are negligible due to the low velocities (1 ft./sec.). Any conduit of similar material with conveyance factor, $AR^{2/3}$, equivalent to that of the 2.5-foot pipe (3.58) will be sufficient. The current plan incorporates two, 2.0-foot diameter pipes which extend the length of the tunnel and combine into a single 2.5-foot diameter pipe at the outlet shaft end.

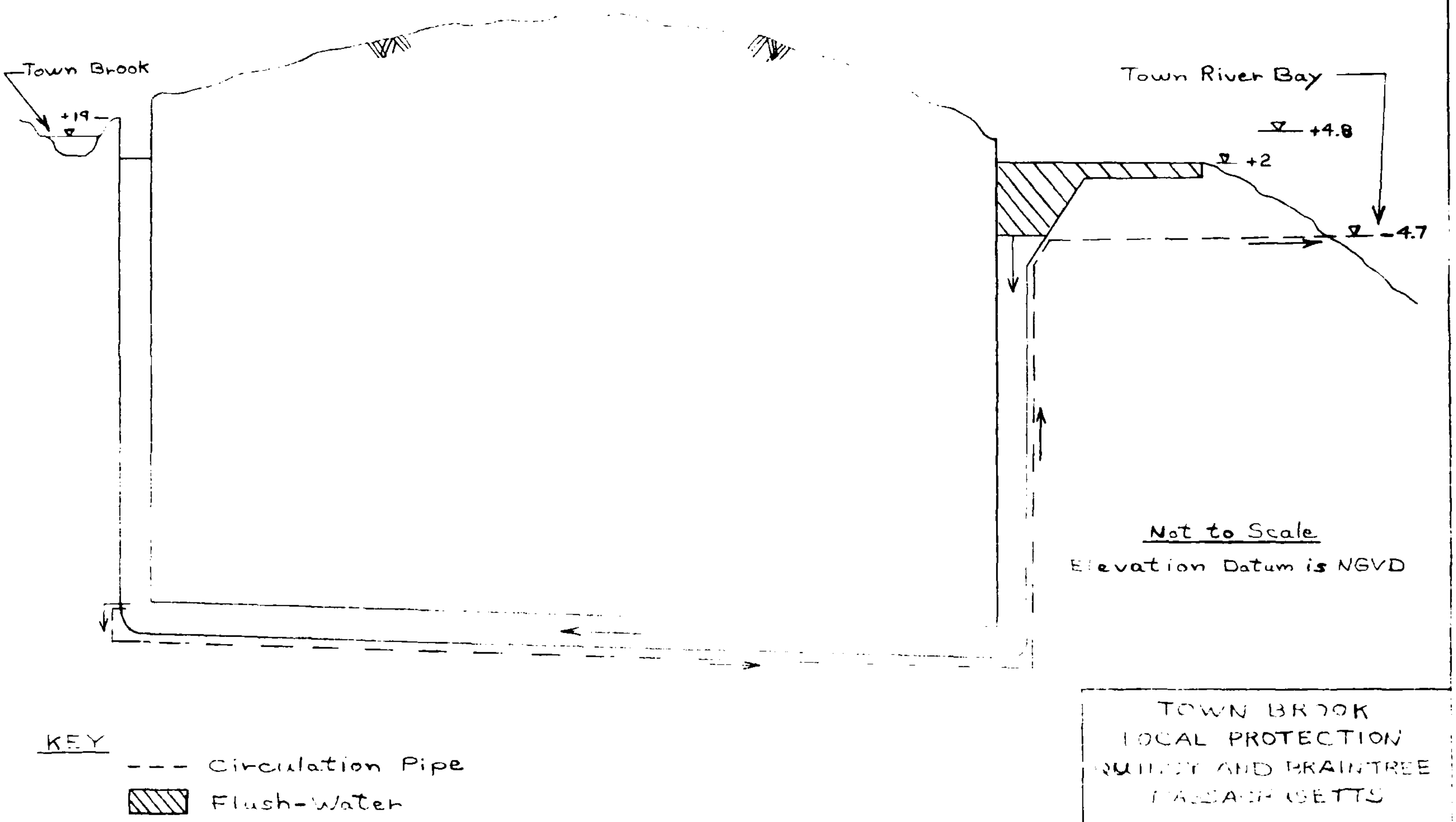
3. FUTURE STUDIES

Extensive detailed studies will be required in the next phase of the project to address the many unknowns concerning the water quality aspects of the action. Specific items to be studied are as follows:

a. Establish baseline water quality conditions. A data collection effort will be required to characterize water quality conditions in Town Brook and Town River including conditions during a high flow period that would be indicative of a diversion event.

b. Evaluate effects of modified operation of Old Quincy Reservoir. Studies will be required to evaluate the effect of surface withdrawal on reservoir water quality and on conditions downstream in Town Brook. Also to be evaluated will be the impact of using reservoir water to flush the tunnel.

c. Conduct studies related to water quality aspects of the diversion tunnel. Potential problems related to long-term storage of water, oxygen depletion, saltwater intrusion, gas generation, etc. will be addressed along with evaluation of impacts downstream in Town River due to the discharge of water from the tunnel. Measures, both structural and nonstructural, to alleviate water quality problems in the tunnel and downstream will be investigated, and a recommended plan of action will be formulated. Laboratory studies of long-term storage of Town Brook and seawater will be performed to simulate tunnel conditions and assist in determining the potential for water quality degradation.



TOWN BROOK
LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

TUNNEL AND
CIRCULATION PIPE

SEPTEMBER 19[illegible]
PLATE 1

Appendix E

Geotechnical Engineering

APPENDIX E

GEOTECHNICAL ENGINEERING

Item		Page
1.	Topographic Features	E-1
2.	Regional Geology	E-1
3.	Seismicity	E-1
4.	Site Investigations	E-1
5.	Site Geology	E-2
6.	Foundation Conditions	E-3
7.	Ground Water Problems	E-6
8.	Settlement Problems	E-6
9.	Construction Materials	E-6
10.	Conclusions and Recommenations	E-6

LIST OF TABLES

1. Tunnel Rock Characteristics

LIST OF PLATES

1. Surficial Geology Map
2. Bedrock Geology Map
3. Plan and Profile of Tunnel Alignment 1
4. Cross-Section through Braintree Dam

APPENDIX E

GEOTECHNICAL ENGINEERING

1. Topographic Features

The topography of the watershed varies from gently rolling hills in the Blue Hills Reservation in the western section of the watershed to flat wetlands (salt marsh) at the mouth of the Town River in the eastern extremity.

The elevations vary from approximately 300 feet above mean sea level in the Blue Hills Reservation to tide level at the mouth of the Town River. The slope of the brook below the Old Quincy Reservoir is very flat, about 2 feet per 1,000.

2. Regional Geology

The Town Brook watershed is underlain in large part by igneous rocks of the Blue Hills Ridge. On a regional scale, this is located in the New England Lowlands portion of the Northern Appalachian Mountains. The Blue Hills Ridge was formed during Ordovician-Devonian time by a series of igneous intrusions and volcanic flows. These penetrated older Cambrian argillite and formed the backbone which now divides the Boston Basin to the north from the Norfolk Basin to the south. Bedrock in the watershed area is covered by glacially deposited sand and gravel and by artificial fill.

3. Seismicity

The Town Brook watershed is located within Zone 3 of the seismic zone map of the United States. This map is a modification of the seismic risk map developed by Environmental Science Administration and the Coast and Geodetic Survey and is contained in Engineering Regulation 1110-2-1806 dated 30 April 1977. In accordance with this directive, a coefficient of 0.10 will be used for the design of all structures.

Detailed remote sensing and fault compilation did not reveal the presence of a major or capable fault within a 75-mile radius of the project area. Thirty-two earthquakes have occurred in that area from 1643 to the present. The nearest event with an epicenter based on non-instrumental data occurred approximately 18 miles from the site in 1744 and had an intensity of VI MM. The nearest event with an epicenter based on instrumental data occurred roughly 19 miles from the site in 1963 and had an intensity of V MM.

4. Site Investigations

Two field reconnaissance trips were made to the project area in order to evaluate conditions along the proposed tunnel lines and at the dam.

A seismic refraction survey and borings were authorized and performed by others. Seismic profiles and boring logs were provided by the Metropolitan District Commission and the boring logs are included in this report. The locations of the borings are shown on Figures E3 and E4.

5. Site Geology

a. Surficial

Overlying bedrock, there is an array of glacial and recent overburden deposits as shown on the map of surficial geology (Fig. E1).

Covering most of the area is glacial till, a medium-dense to dense, unsorted mixture of sand, gravel, silt, clay and boulders. Seismic velocities of roughly 7,000 feet per second characterize the till. It directly overlies bedrock, averaging 10 to 20 feet thick. The till becomes exposed at the surface in upland areas where soil cover is thin. Stratified drift and glacial outwash are low- to medium-dense deposits of sand and gravel. Seismic velocities of approximately 5,000 feet per second characterize these deposits. The stratified drift and glacial outwash deposits average 10 to 30 feet thick and generally overlie the till in lowland areas such as downtown Quincy. Other glacial deposits, present mostly in the western portion of the watershed, are irregular hills and ridges of unsorted sand and gravel (kames), and undifferentiated sand and gravel deposits.

In addition to glacial overburden, more recent deposits of sand, silt and peat have accumulated along streambeds such as Town Brook. These deposits consist of approximately five feet of soft peat underlain by medium-dense silt and fine sand. In addition, an average of five feet of recent sand and silt is found at the surface, overlying the glacial deposits. Seismic velocities of 1,500 feet per second characterize the recent sand and silt deposits.

A significant portion of the surficial geology has been covered or replaced by artificial fill. Especially in the eastern half of the area, which is fully developed, three to five feet of fill is almost always present. This material is highly variable in density and composition.

A buried deep valley, trending north and coinciding with a fault zone, exists near Parking Way in downtown Quincy. Based on seismic data, this valley is filled with up to 20 feet of recent material, 50 feet of stratified drift and outwash deposits, and 70 feet of till and/or poorly consolidated rock.

b. Bedrock.

Bedrock formations specifically present beneath the site are the Weymouth and Braintree argillite formations, the Quincy granite, and the Mattapan Volcanics. Their general distribution is indicated on the map of bedrock geology (Fig. E2).

The oldest formation is the Weymouth argillite, which occurs as outcrops north of the Daniel Webster School. It is a dark gray, massive siliceously cemented argillite.

The Braintree formation was observed in bedrock core from the lower end of Town Brook and in both outcrop and core from the Old Quincy Reservoir area. In lower Town Brook, it is a light greenish-gray, massive agrillite containing layers of medium grained sandstone dipping between 60° and 90°. Beneath the Old Quincy Reservoir, the Braintree formation becomes a dark gray slate which is fissile with a strike of 285° (N75°W) and a vertical dip.

Intruding these sediments is the Quincy granite. It is medium to coarse grained and pink in color. It has been quarried as monument and building stone for 300 years, and underlies many of the topographic highs in the area, such as Pine Hill and Mt. Ararat. Surface outcrops are rounded, massive, and resistant, with generally widely spaced joints. Contacts with other formations are intrusive, and the granite characteristically becomes very fine grained near these contact areas.

The Mattapan Volcanics are the youngest rocks in the watershed and can be seen in road cuts along Route 128. They vary from a light to dark gray, slightly porhyritic rhyolite to a medium grained, maroon granite porphyry. In places, the rhyolite has been altered (pyritization) to a light green color. The outcrops are resistant with widely spaced joints and numerous quartz veins.

A fault zone trending about 350° (N10°W) exists beneath downtown Quincy as shown on the bedrock geology map (Fig. E2). This is based on a displacement of the granite north of the site. The seismic survey at this site revealed a deep, steep-walled valley roughly 200 feet wide. The fault plane itself is not exposed in the field, and its condition and extent are presently not known.

6. Foundation Conditions

a. Channels and Structures.

In general, peat deposits are indicated at various locations along the brook channel from 3 to 9 feet thick and of varying extent. Where the new surface structures increase concentrated loads, the peat should be completely removed, but if loadings do not exceed present soil loads, stabilization of the material immediately under the structure with a gravel pad may be a sufficient foundation treatment. The proposed channels along Town River are expected to be in soft soils where side slopes will require stabilization and protection.

b. Tunnel and Shafts

(1) Alignment 1

(a) Shafts

The intake shaft with the intake structure is estimated to be 194 feet in depth, passing through 58 feet of overburden and 136 feet of bedrock. The outlet shaft is estimated to be 188 feet in depth, passing through 41 feet of overburden and 147 feet of bedrock.

The overburden at the intake and outlet is stratified, with very dense glacial till at the bottom overlain by medium to dense deposits of gravel, sand, silt or clay. Ground water inflows could be severe in granular layers, requiring special treatment in addition to normal dewatering methods.

The bedrock at the intake is Quincy granite, which is hard and unweathered but somewhat fractured. Core from boring D-13 average 79 percent RQD, containing low angle joints with slightly stained surfaces. Slight to moderate inflows of water could be expected from open joints.

The bedrock at the outlet is the Braintree argillite. Core from boring D-16 averaged 62 percent RQD, containing joints dipping 40^{o}. The joint surfaces are slightly stained and many are partially healed with calcite. Slight to moderate ground water inflow can be expected.

(b) Tunnel

From the intake shaft, the first 3,000 feet of tunnel will be through Quincy granite. Relatively good crown rock requiring a minimum of temporary support, was found at the intake area where recoveries were near 100 percent and RQD's generally over 85 percent. Boring D-14, drilled near the alignment at Station 22+40, indicated a poorer quality crown rock. Recoveries were in the 80 percent range and RQD's averaged 61 percent, a condition which will require light to medium temporary steel support during construction.

The bedrock structure is massive, and the rock should fracture along joint planes which dip at 20^{o}. Ground water inflows are expected to be slight to moderate, depending on the frequency of open joints. Overbreak is estimated to be up to 2.1 feet from crest to trough on each wall.

The remaining 1,000 feet of tunnel will be excavated through argillite of the Weymouth and Braintree formations. Good crown rock was not encountered in boring D-16. Recoveries were generally good; however, RQD's averaged only 62 percent and appeared to decrease with depth. This rock condition could require medium to heavy temporary steel support during construction.

The argillites contain thin layers of clay to fine sand sized particles which are siliceously cemented and medium hard. Bedding dips between 60^{o} and 90^{o}. The Weymouth argillite was examined in surface outcrop but not in bedrock core. Being of similar composition as the Braintree argillite, it is assumed that its tunneling characteristics will also be similar.

Available geologic data suggests the presence of a fault zone roughly 900 feet east of the intake. Based on data obtained from the seismic survey, it is estimated that the fault zone is over 200 feet wide. The rock quality will likely be poor, reflected by somewhat lower seismic velocities in the area then for similar competent rock. The rock condition in the fault zone will almost certainly require heavy temporary steel support during construction. The actual characteristics of the rock in the fault zone will be carefully defined by borings prior to final design.

Basic data on the tunnel rock are presented in Table 1. The geologic profile along the tunnel is presented in Figure E3.

(2) Alignments 2 and 3

The intake shaft location is common to all tunnel options and as discussed previously, boring D-13 defines the foundation conditions.

Alignment 2 extends for roughly 3,500 feet, with the first 2,500 in the Quincy granite. The remainder of the tunnel will be excavated through the Weymouth and Braintree argillites. It is anticipated that bedrock and tunneling conditions would be similar to those found in Alignment 1.

The outlet shaft conditions are defined by boring D-17. Roughly 70 feet of overburden, consisting of glacial till overlain by medium to dense sand, gravel, silt and clay will be encountered. The underlying bedrock is the Braintree argillite. It was quite similar to that found in boring D-16, although the RQD's were lower, averaging only 52 percent. The required temporary support would be similar to that required at D-16, Alignment 1.

Alignment 3 extends for approximately 5,700 feet. Although no borings are located along this alignment, it is assumed that subsurface conditions do not differ radically from Alignments 1 or 2.

(c) Old Quincy Reservoir

Borings D-1, D-21, D-22, and D-23 define the foundation conditions at the Braintree Dam. The dam embankment is composed of fine to coarse sand fill which is generally medium to dense but occasionally loose. Underlying the fill is about 8 feet of naturally deposited gravelly silty sand, varying from loose to very dense. The underlying bedrock is a fractured slate member of the Braintree formation. A cross section of the dam indicating soil types is shown on Figure E4.

The proposed new spillway, located at the southern end of the dam, will be located adjacent to the existing spillway. The borings along the dam indicate uniformity within the overburden. The embankment fill overlying gravelly sand is of adequate strength to support the proposed spillway structure. Cutoff walls to prevent seepage along the bottom and sides of the spillway structure will be required. Piezometers installed in boring D-21, D-22, and D-23 indicate a drop in head of about 16 feet between P-1 and P-3, showing that water flow is impeded by a relatively impervious core well.

Based on the November 1979 Non-Federal Dam Inspection Report, major modifications to the dam are needed. These include a new spillway, reconstruction of the downstream slopes with a toe drain, repair of the upstream stone protection, and regrading the top of the dam to elevation +85 feet MSL.

7. Ground Water Problems

a. Tunnels

Based on boring data, ground water can be found within 10 feet of the surface. Tunnel shaft construction is expected to entail major dewatering operations, resulting from high inflows from coarse layers in the overburden. Most of the tunnel is in fractured rock and moderate inflow will have to be pumped out. A fault zone is expected which could produce a series of high water bearing fractures.

b. Surface Structures

At the Old Quincy Reservoir, the water level will be lowered as much as is practicable to facilitate construction of the low overflow structure and the new spillway.

8. Settlement Problems

Beneath the tunnel inlet structure that is a buried layer of soft silt, approximately 4 feet thick. In view of the light loading, anticipated settlements will be small. To avoid possible damage from differential settlement between the shaft lining founded in bedrock and the rest of the structure, their juncture wil be designed to accommodate vertical movement on the order of one inch.

At the outlet structure sites, compressible soils occur up to 8 feet in thickness below the proposed grade of the structure. This material will be removed and replaced with compacted gravel fill. A flexible juncture will be provided between the shaft lining and the structure.

9. Construction Materials

It is anticipated that all construction materials can be obtained within a 20 mile radius of the project area.

Rock for slope protection can be obtained from the Quincy granite quarries. Aggregate for concrete can be obtained from quarries and numerous sand and gravel pits in the area. Limited quantities of impervious material, if needed, could be obtained directly from the dense overburden layers at the project site.

10. Conclusions and Recommendations

From a geotechnical standpoint, the Town Brook Relief Tunnel and Braintree Dam improvement are considered feasible.

The following recommendations are made:

a. Borings to the anticipated tunnel grade, especially in the fault zone area, should be made prior to any further studies.

b. Ground water withdrawal must be controlled to reduce the risk of settlement to adjacent structures, such as building foundations and street utilities.

c. Primary support of the tunnel using rock bolts, ties and steel supports will be required, depending on the rock conditions. If tests indicate the argillite is subject to slaking, shotcrete may be applied to minimize fallouts.

Table 1. TUNNEL ROCK CHARACTERISTICS

Characteristic	Granite	Argillite
Color	Pink	Light green-gray to dark gray
Unconfined compressive strength	13,000 psi	7,000 psi
Core recovery	60-100%	30-100%
RQD	33-100%	27-100%
Dip of Major Jointing	20°	40°

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 1 OF 1

DATE

HOLE NO. D-1

LINE & STA.

OFFSET

SURF. ELEV. 80.99 Mean Sea Level

Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.

PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.

REPORT SENT TO above PROJ. NO. E-444

SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR		Date	Time
At 7'6" after ___ Hours In Casing	Rods-"AW" Type	BW	S/S		START	8/25/75	
	Size I.D.	2½"	1 3/8"		COMPLETE	8/25/75	
At ___ after ___ Hours	Hammer Wt.	300#	140#	BIT	TOTAL HRS.		
	Hammer Fall	24"	30"		BORING FOREMAN	R. Long	
					INSPECTOR	P. Lydon	
					SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	Sample No.	Pen	Rec.
	3	0.0'-0.5'	D	4/6"	D/v/loose	6"	Brown F-C SAND, little F-M gravel, Fill	1	6"	3"
	4	1'-2'	D	13	Dry medium dense		Brown fine to medium SAND, trace of fine gravel	2	12"	6"
	5									
	6									
	5					5'				
	17	5.5'-6.5'	D	14	Wet medium dense		Brown fine to coarse SAND, some fine gravel, trace of silt	3	12"	9"
	18									
	18									
	18									
	18					10'				
	6	10.5'-11.5'	D	12	Wet medium dense		Brown fine SAND, some silt, trace of fine gravel	4	12"	11"
	6									
7	12									
	11									
	13					15'				
		15.5'-16.5'	D	13	Wet medium dense		Brown very fine SAND and Silt	5	12"	9"
		19'-20'	D	13	"	20'		6	12"	10"
							Bottom of Boring 20'			

GROUND SURFACE TO 15' USED BW CASING: THEN S/S to 20'

Sample Type	Proportions Used	140 lb Wt. x 30" fall on 2" O.D. Sampler Cohesionless Density	Cohesive Consistency	SUMMARY
D=Dry C=Cored W=Washed	trace 0 to 10%	0-10 Loose	0-4 Soft 30 + Hard	Earth Boring 20'
UP=Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff	Rock Coring
TP=Test Pit A=Auger V=Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples 6
UT=Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff	HOLE NO D-1

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 1 OF 1

DATE

HOLE NO. D-2

LINE & STA.

OFFSET

SURF. ELEV. 69.70 Mean Sea Lev

TO Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.

PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.

REPORT SENT TO above PROJ. NO. E-444

SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 8' after ______ Hours
In Casing

At ______ after ______ Hours

Rods-"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	8/25/75	a.m. p.m.
COMPLETE	8/25/75	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN R. Long

INSPECTOR P. Lydon

SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	6					6"	Loamy Sand			
	5	1'-2'	D	11	Dry		Brown fine SAND, trace of	1	12"	12"
	7				medium		fine gravel, Fill			
	6				dense					
	5					5'				
	7	5.5'-6.5'	D	19	Moist		Rusty Brown Gray fine SAND,	2	12"	12"
	8				medium		little silt, Fill			
	6				dense					
	4					9'				
	3									
	5	10.5'-11.5'	D	5	Moist		Dark Brown fibrous PEAT	3	12"	10"
	6				medium					
	7				stiff					
	8									
	9									
	13	15.5'-16.5'	D	3	Moist			4	12"	12"
	10				soft					
	13									
	13									
	13					20'				
		20.5'-21.5'	D	17	Wet		Gray fine SAND, some silt	5	12"	8"
					medium					
					dense					
		24'-25'	D	18	"	25'		6	12"	9"
							Bottom of Boring 25'			

GROUND SURFACE TO 20' USED BW CASING THEN S/S to 25'

140 lb Wt x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used	Cohesionless Density	Cohesive Consistency	SUMMARY
D=Dry C=Cored W=Washed	trace 0 to 10%	0-10 Loose	0-4 Soft 30 + Hard	Earth Boring 25'
UP=Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff	Rock Coring
TP=Test Pit A=Auger V=Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples 6
UT=Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff	

HOLE NO D-2

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg ______
Bit # ______ Ftg ______

SHEET 1 OF 1
DATE ______
HOLE NO. D-3
LINE & STA. ______
OFFSET ______
SURF. ELEV. 67.76 Mean Sea Level

TO Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy-Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 8'2" after ______ Hours
In Casing

At ______ after ______ Hours

Rods-"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	AX
Size I.D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	Dia.

	Date	Time
START	8/25/75	a.m. p.m.
COMPLETE	8/26/75	a.m. p.m.

TOTAL HRS. ______
BORING FOREMAN R. Long
INSPECTOR P. Lydon
SOILS ENGR. ______

LOCATION OF BORING: ______

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	10	0'-1'	D	13	D/m/dense	1'	Br. fine SAND, little F-M gravel, Fill	1	12"	8"
	12				Dry/m		Brown fine SAND, trace of			
	13	1.5'-2.5'	D	25	dense	3'	fine gravel	2	12"	12"
	20									
	24									
	39	5.5'-6.5'	D	55	Dry		Brown fine to medium SAND,	3	12"	10"
	61				very		little fine to medium gravel,			
	75				dense		Boulders			
	61									
	64					9.5'				
	47	10.5'-11.5'	D	50	Moist		Brown coarse to fine SAND,	4	12"	9"
	61			(300# Wt.	dense		some fine to coarse gravel,			
	75						trace of silt, Boulders			
	74									
	78			(300# Wt.)		15'				
		15'-16'	D	66	W/v/d	16'	Yellow Brown fine to coarse SAND & Gravel, trace of silt, Boulders	5	12"	9"
				Min/ft	10					
		16'-21'	C		12		Gray Pink GRANITE, Hard &	C1	60"	35"
					11		Seamy			
					10					
					12	21'	(Lost Water Drilling Rock)			
							Bottom of Boring 21'			

GROUND SURFACE TO 16' USED BW CASING THEN Cored to 21'

Sample Type: D=Dry C=Cored W=Washed; UP=Undisturbed Piston; TP=Test Pit A=Auger V=Vane Test; UT=Undisturbed Thinwall

Proportions Used: trace 0 to 10%; little 10 to 20%; some 20 to 35%; and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density: 0-10 Loose; 10-30 Med Dense; 30-50 Dense; 50 + Very Dense

Cohesive Consistency: 0-4 Soft; 4-8 M/Stiff; 8-15 Stiff; 15-30 V. Stiff; 30 + Hard

SUMMARY
Earth Boring 16'
Rock Coring 5'
Samples 5

HOLE NO. D-3

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE
HOLE NO. D-4
LINE & STA.
OFFSET
SURF. ELEV. 72.06 Mean Sea Level

TO Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy-Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR		Date	Time
At ____ after ____ Hours	Rods-"AW" Type	BW	S/S	AX	START	8/26/75	a.m. p.m.
No Water Level	Size I.D.	2½"	1 3/8"		COMPLETE	8/26/75	a.m. p.m.
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	TOTAL HRS.		
	Hammer Fall	24"	30"	Dia.	BORING FOREMAN	R. Lock	
					INSPECTOR	P. Lydon	
					SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	7					6"	Loamy Sand & Gravel			
	10	1'-2'	D	40	Moist		Brown fine SAND, little silt	1	12"	11"
	6/6"				dense	2.5'	& fine to medium gravel			
		2.5'-7.5'	C	Min/ft	30		Gray Pink GRANITE, Very Hard	C1	60"	43"
					32					
					31					
					29					
					30	7.5'	(Lost Water Drilling Rock @ 3')			
							Bottom of Boring 7.5'			

GROUND SURFACE TO 2.5' USED BW CASING THEN Cored to 7.5'

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY
Earth Boring 2.5'
Rock Coring 5'
Samples 1

HOLE NO D-4

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg ______

Bit # ______ Ftg ______

SHEET	1 OF 1
DATE	
HOLE NO.	D-5
LINE & STA.	
OFFSET	30.42
SURF. ELEV.	

TO: Comm.Of Mass.-M.D.C.Engr.Div. ADDRESS Boston, Mass.

PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree,Mass.

REPORT SENT TO above PROJ. NO. E-444

SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 7½ after 1/4 Hours

At ______ after ______ Hours

Rods"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	9/8/75	
COMPLETE	"	
TOTAL HRS.		
BORING FOREMAN	Allen	
INSPECTOR	Selados	
SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	2	0'-1'	D	5	moist			1	12"	12"
	5				loose		Brown fine-medium SAND, little			
	4						silt, trace fine-medium gravel			
	2						(FILL) ?			
	20					5'				
	20	5'-6'	D	21	wet			2	12"	8"
	8				very					
	16				stiff		Brown SILT, some layers of very			
	20						fine sand			
	22				"					
		10'-11'	D	20				3	12"	10"
		15'-16'	D	33	wet			4	12"	10"
					hard					
					wet					
					very					
		20'-21'	D	26	stiff	21'		5	12"	10"
							Bottom of Boring - 21'			

GROUND SURFACE TO 10' USED BW CASING THEN Sampled to 21'

Sample Type: D-Dry C-Cored W-Washed; UP-Undisturbed Piston; TP-Test Pit A-Auger V-Vane Test; UT-Undisturbed Thinwall

Proportions Used: trace 0 to 10%; little 10 to 20%; some 20 to 35%; and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4 Soft	30 + Hard
10-30	Med Dense	4-8 M/Stiff	
30-50	Dense	8-15 Stiff	
50 +	Very Dense	15-30 V-Stiff	

SUMMARY

Earth Boring 21'

Rock Coring ______

Samples 5

HOLE NO. D-5

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 1 OF 1

DATE

HOLE NO. D-6

LINE & STA.

OFFSET

SURF. ELEV. 26.80 Mean Sea Level

TO Comm. of Mass. - M.D.C. Engr. Div.

ADDRESS Boston, Mass.

PROJECT NAME Town Brook Flood Control

LOCATION Quincy/Braintree, Mass.

REPORT SENT TO above

PROJ. NO. E-444

SAMPLES SENT TO "

OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR
At 6" after 1/4 Hours	Rods-"AW" Type		BW	S/S	
At ______ after ______ Hours	Size I.D.		2½"	1 3/8"	
	Hammer Wt.		300#	140#	BIT
	Hammer Fall		24"	30"	

	Date	Time
START	8/28/75	
COMPLETE	8/28/75	
TOTAL HRS.		

BORING FOREMAN K. Allen

INSPECTOR G. Selanos

SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	1	0'-1'	D	1	Wet		Brown PEAT	1	12"	12"
	1				very					
	1				soft	3'				
	12									
	12									
	12	5'-6'	D	16	Wet		Brown SILT, some layers of	2	12"	12"
	12				very		very fine sand			
	15				stiff					
	18									
	18									
		10'-11'	D	10	Wet			3	12"	12"
					stiff					
		14'-15'	D	11	"	15'		4	12"	12"
							Bottom of Boring 15'			

GROUND SURFACE TO 10' USED BW CASING THEN Washed & Sampled to 15'

Sample Type	Proportions Used	140 lb Wt x 30" fall on 2" O.D. Sampler Cohesionless Density	Cohesive Consistency	SUMMARY
D=Dry C=Cored W=Washed	trace 0 to 10%	0-10 Loose	0-4 Soft 30 + Hard	Earth Boring 15'
UP=Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff	Rock Coring
TP=Test Pit A=Auger V=Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples 4
UT=Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff	HOLE NO. D-6

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE
HOLE NO. D-7
LINE & STA.
OFFSET
SURF. ELEV. 29.83 MSL Mean Sea Level

TO Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 6' after ____ Hours In Casing

At ______ after ______ Hours

Rods-"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	8/26/75	a.m. p.m.
COMPLETE	8/26/75	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN R. Long
INSPECTOR P. Lydon
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	6					6"	Loamy Sand			
	8	1'-2'	D	4	Moist		Dark Brown PEAT & fine Sand,	1	12"	10"
	10				soft		little fine to medium gravel			
	12									
	14					4.5'				
	13	5.5'-6.5'	D	11	Moist		Gray Brown fine SAND, some	2	12"	12"
	12				medium		silt, little fine to medium			
	18				dense	8'	gravel, trace of peat			
	22									
	29									
		10.5'-11.5'	D	31	Moist		Gray very fine SAND & Silt	3	12"	12"
					compact					
		15.5'-16.5'	D	37	"			4	12"	12"
		19'-20'	D	43	"	20'		5	12"	12"
							Bottom of Boring 20'			

GROUND SURFACE TO 10' USED BW CASING THEN S/S to 20'

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency			
0-10	Loose	0-4	Soft	30 +	Hard
10-30	Med Dense	4-8	M/Stiff		
30-50	Dense	8-15	Stiff		
50 +	Very Dense	15-30	V-Stiff		

SUMMARY
Earth Boring 20'
Rock Coring
Samples 5

HOLE NO D-7

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE
HOLE NO. D-8
LINE & STA.
OFFSET
SURF. ELEV. 29.08 Mean Sea Level

TO Comm. of Mass.-M.D.C.Egr.Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS
At 7.5' after ____ Hours
In casing
At ____ after ____ Hours

Rods "AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	8/27/75	a.m. p.m.
COMPLETE	"	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN Long
INSPECTOR Lyndon
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	21	0.5'-1.5'	D	26	dry		Gray fine SAND, little fine	1	12"	12"
	30				dense		gravel, trace silt - FILL			
	41									
	46					4'				
	15									
	18	5.5'-6.5'	D	4	moist		Gray Organic SILT, little peat	2	12"	13"
	13				soft		& fine sand			
	12									
	10					9'				
	31									
	26	10.5'-11.5'	D	22	wet		Gray fine-coarse SAND & Gravel	3	12"	12"
	25				medium		little silt			
	21				dense					
	24					14'				
	22									
	29	15.5'-16.5'	D	32	moist			4	12"	12"
	21				dense		Brown fine-medium SAND, little			
	23						fine gravel, trace silt			
	10									
		19'-20'	D	31	"	20'		5	12"	12"
							Bottom of Boring- 20'			

GROUND SURFACE TO 18.5' USED BW CASING THEN S/S to 20'

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY
Earth Boring 20'
Rock Coring
Samples 5

HOLE NO. D-8

American Drilling & Boring Co., Inc.
100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE 9
HOLE NO. D-9
LINE & STA.
OFFSET
SURF. ELEV. 31.53 Mean Sea Lev

TO Comm. of Mass.-M.D.C.Engr.Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS	Rods "AW"	CASING	SAMPLER	CORE BAR		Date	Time
At 8'6" after ___ Hours	Type	BE	S/S		START	8/27/85	a.m. p.m.
In casing	Size I.D.	2½"	1-3/8"		COMPLETE	"	a.m. p.m.
At ___ after ___ Hours	Hammer Wt.	300#	140#	BIT	TOTAL HRS.		
	Hammer Fall	24"	30"		BORING FOREMAN	Long	
					INSPECTOR	Lyndon	
					SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	6	0.5'-1.5'	D	22	dry		Black/brown fine SAND & Gravel	1	12"	12"
	10				medium		some blacktop - FILL			
	10				dense	3'				
	8						Brown fine SAND, some peat			
	9									
	7	5'-6'	D	40	moist	6'		2	12"	12"
	15	6.5'-7.5'	D	22	loose		Brown fine SAND, little fine	3	12"	12"
	29				moist	7.5'	Gravel, some silt			
	31				medium					
	50				dense					
	44	10.5'-11.5'	D	64	moist			4	12"	12"
	47				very		Gray/brown coarse-fine SAND &			
	50				dense		Gravel, some silt, Boulders			
	53									
	60									
	50	15.5'-16.5'	D	50	moist			5	12"	9"
	46				dense					
	40									
	45									
		19'-20'	D	50	"	20'		6	12"	8"
							Bottom of Boring 20'			

GROUND SURFACE TO 18.5' USED BW CASING THEN S/S to 20'

Sample Type	Proportions Used	140 lb Wt. x 30" fall on 2" O.D. Sampler		SUMMARY
D = Dry C = Cored W = Washed	trace 0 to 10%	Cohesionless Density	Cohesive Consistency	Earth Boring 20'
UP = Undisturbed Piston	little 10 to 20%	0-10 Loose	0-4 Soft 30 + Hard	Rock Coring
TP = Test Pit A Auger V = Vane Test	some 20 to 35%	10-30 Med. Dense	4-8 M/Stiff	Samples 6
UT = Undisturbed Thinwall	and 35 to 50%	30-50 Dense	8-15 Stiff	HOLE NO. D-9
		50 + Very Dense	15-30 V-Stiff	

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE ______
HOLE NO. D-10
LINE & STA. ______
OFFSET ______
SURF. ELEV. 27.82 Mean Sea Leve

TO Comm. of Mass. Engr. Div, M.D.C.
ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control
LOCATION Quincy/Braintree, Mass.
REPORT SENT TO above
PROJ. NO. F-444
SAMPLES SENT TO "
OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 9.2' after ______ Hours
In casing
At ______ after ______ Hours

Rods "AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	8/27/75	a.m. p.m.
COMPLETE	"	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN Ling
INSPECTOR Lyndon
SOILS ENGR. ______

LOCATION OF BORING: ______

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	7	0.5'-1.5'	D	15	dry			1	12"	10"
	6				medium					
	10				dense		Brown fine-medium SAND &			
	8						Gravel, glass - FILL			
	7									
	10	5.5'-6.5'	D	18	"			2	12"	9"
	11									
	12					8'				
	18									
	16									
	21	10.5'-11.5'	D	27	wet			3	12"	12"
	25				medium					
	31				dense		Gray/brown SAND & Gravel, small			
	32						Boulders, little silt			
	30									
	30	15.5'-16.5'	D	29	"			4	12"	12"
	29									
	20									
	13									
		19'-20'	D	30	"	20'		5	12"	10"
							Bottom of Boring - 20'			

GROUND SURFACE TO 18.5' USED BW CASING THEN S/S to 20'

Sample Type	Proportions Used	140 lb Wt x 30" fall on 2" O.D. Sampler — Cohesionless Density	Cohesive Consistency	SUMMARY
D Dry C Cored W Washed	trace 0 to 10%	0-10 Loose	0-4 Soft 30 + Hard	Earth Boring 20'
UP Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff	Rock Coring ______
TP Test Pit A Auger V Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples 5
UT Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff	HOLE NO 10

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 1 OF 1

DATE ______

HOLE NO. D-11

LINE & STA. ______

OFFSET ______

SURF. ELEV. 35.11 Mean Sea Lev

TO Comm.ofMass.M.D.C.Engr.Div. ADDRESS Boston, Mass.

PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.

REPORT SENT TO above PROJ. NO. E-444

SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 23'6" after ______ Hours
In casing

At ______ after ______ Hours

Rods"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	8/28/75	a.m. p.m.
COMPLETE	"	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN Long

INSPECTOR Lyndon

SOILS ENGR. ______

LOCATION OF BORING: ______

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	8				dry	1'	Loamy SAND, Gravel - FILL			
	12	1.5'-2.5'	D	27	medium			1	12"	12"
	14				dense					
	10						Brown fine-medium SAND, some			
	20						fine-medium gravel, little silt			
	24	5.5'-6.5'	D	31	dry			2	12"	12"
	26				dense					
	40									
	44					9'				
	59									
	50	10.5'-11.5'	D	71	moist		Gray coarse-fine SAND & Gravel	3	12"	12"
	48				very		& Boulders, trace of silt			
	40				dense	13'				
	39									
	25									
	20	15.5'-16.5'	D	12	moist			4	12"	12"
	18				medium					
	20				dense		Brown fine SAND, little silt			
	17									
	18									
	17	20.5'-21.5'	D	10	moist			5	12"	12"
	18				loose					
	19									
	18									
	16									
		25.5'-26.5'	D	11	moist			6	12"	12"
					medium					
					dense					
					wet					
		29'-30'	D	10	loose	30'		7	12"	12"
							Bottom of Boring- 30'			

GROUND SURFACE TO 25' USED BW CASING THEN S/S to 30'

Sample Type
D Dry C Cored W Washed
UP Undisturbed Piston
TP Test Pit A Auger V Vane Test
UT Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density
0-10 Loose
10-30 Med Dense
30-50 Dense
50 + Very Dense

Cohesive Consistency
0-4 Soft 30 + Hard
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff

SUMMARY
Earth Boring 30'
Rock Coring ______
Samples 7

HOLE NO 11

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE ______
HOLE NO. D-12
LINE & STA. ______
OFFSET ______
SURF. ELEV. 29.34 Mean Sea Lev

TO Comm.of Mass.-M.D.C.Engr.Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree,Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS
At 8'6" after ___ Hours
Incasing
At ______ after ___ Hours

Rods "AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	16"	30"	

	Date	Time
START	8/28/75	a.m. p.m.
COMPLETE	"	a.m. p.m.

TOTAL HRS. ______
BORING FOREMAN Long
INSPECTOR Lyndon
SOILS ENGR. ______

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	10	0.5'-1.5'	D	36	moist		Brown fine SAND, some fine	1	12"	12"
	14				dense	2'6"	gravel, little silt - FILL			
	30									
	72									
	83						Gray/brown fine-medium SAND &			
	75	5.5'-6.5'	D	102	dry		Gravel, some boulders, little	2	12"	12"
	69				very		silt			
	60				dense					
	31					9'				
	40									
	30	10.5'-11.5'	D	[illegible]	wet		Brown fine-coarse SAND, some	3	12"	12"
	28				medium		fine-coarse gravel, trace of			
	20				dense		silt			
	18					14'				
	17									
	10	15.5'-16.5'	D	23	"			4	12"	12"
	15						Brown fine SAND, trace silt			
	16									
	17									
	20									
		20.5'-21.5'	D	12	"			5	12"	9"
		24'-25'	D	[illegible]		25'		6	12"	8"
							Bottom of Boring- 25'			

SUMMARY
Earth Boring 25'
Rock Coring ______
Samples 6

HOLE NO. 12

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 1 OF 3
DATE
HOLE NO. D-13
LINE & STA.
OFFSET
SURF. ELEV. 22.07 Mean Sea Level

TO Comm.of Mass.-M.D.C.Engr.Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree,Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR
At 8' after 1/4 Hours	Rods "AW" Type	BW	S/S	AXD3
	Size I.D.	2½"	1=3/8"	
At ______ after ______ Hours	Hammer Wt.	300#	140#	BIT
	Hammer Fall	24"	30"	dia

	Date	Time
START	9/4/75	a.m. p.m.
COMPLETE	9/8/75	a.m. p.m.
TOTAL HRS.		
BORING FOREMAN	Allen	
INSPECTOR	Selados	
SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	1	0'-1'	D	4	dry		Brown fine-medium SAND, little	1	12"	8"
	4				very		silt & fine-medium gravel			
	7				loose	3'6"	(FILL?)			
	5									
	6						Brown fine SAND & Peat,			
	3	5'-6'	D	6	wet		little fine-coarse gravel	2	12"	7"
	7				loose	7'6"				
	4									
	12						Brown fine-medium SAND, some			
	12						silt & fine-medium gravel			
	6	10'-11'	D	9	"			3	12"	10"
	5									
	12									
	14									
	15					15'				
	5	15'-16'	D	14	wet			4	12"	10"
	10				medium		Brown fine SAND, some silt			
	18				dense	18'				
	5									
	3						Brown SILT (Plastic)			
	17	20'-21'	D	3	wet soft			5	12"	12"
	20				soft	22'				
	22									
	30									
	32									
	17	25'-26'	D	13	wet			6	12"	10"
	10				medium					
	12				dense		Brown fine-coaser SAND,			
	20						some fine-coarse gravel, trace			
	22						silt			
	26	30'-31'	D	23	"			7	12"	8"
	16									
	22									
	25									
	24				"					
	25	35'-36'	D	23				8	12"	8"
	21									
	20									
	20									
	22									

GROUND SURFACE TO 59' USED BW CASING THEN cored to 94'

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY
Earth Boring 59'
Rock Coring 35'
Samples 12

HOLE NO. D-13

American Drilling & Boring Co., Inc.

100 WATER STREET   EAST PROVIDENCE, R.I.

Bit # ______ Ftg ______

Bit # ______ Ftg ______

SHEET 2 OF 3
DATE ______
HOLE NO. D-13
LINE & STA. ______
OFFSET ______
SURF. ELEV. ______

TO ______ ADDRESS ______
PROJECT NAME ______ LOCATION ______
REPORT SENT TO ______ PROJ. NO. ______
SAMPLES SENT TO ______ OUR JOB NO. ______

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR
At ______ after ______ Hours	Type			
	Size I.D.			
At ______ after ______ Hours	Hammer Wt.			BIT
	Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		

BORING FOREMAN ______
INSPECTOR ______
SOILS ENGR. ______

LOCATION OF BORING: ______

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	34	40'-41'						9	12"	6"
	42						Brown fine-coarse SAND,			
	60						some fine-medium gravel, trace			
	60						of silt			
	55									
	19	45'-46'						10	12"	6"
	17									
	22									
	24									
	32									
		50'-51'						11	12"	8"
							Gray fine-medium SAND, some silt,			
							little fine-medium gravel			
		55'-56'						12	12"	9"
							Top of Rock			
		59'-62'2"						C1	38"	38"
							(8 min/ft-drill time)			
		62'2"-67'						C2	58"	58"
							Pinkish GRANITE			
							hard & slightly fractured			
		67'-72'						C3	60"	60"
		72'-77'						C4	60"	60"
		77'-82'						C5	60	60"

GROUND SURFACE TO ______

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger
UT=Undisturbed Thinwall

SUMMARY
Earth Boring ______
Rock Coring ______
Samples ______

HOLE NO. D-13

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 3 OF 3

DATE ______

HOLE NO. D-13

LINE & STA. ______

OFFSET ______

SURF. ELEV. ______

TO ______ ADDRESS ______

PROJECT NAME ______ LOCATION ______

REPORT SENT TO ______ PROJ. NO. ______

SAMPLES SENT TO ______ OUR JOB NO. ______

GROUND WATER OBSERVATIONS

At ______ after ______ Hours

At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		

BORING FOREMAN ______

INSPECTOR ______

SOILS ENGR. ______

LOCATION OF BORING: ______

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	SAMPLE Pen	SAMPLE Rec.
		82'-85'	C					C6	36"	33"
		85'-90'	C				Pinkish GRANITE hard & slightly fractured	C7	60"	52"
		90'-94'	C					C8	48"	48"
						94'				
							Bottom of Boring- 94'			

GROUND SURFACE TO ______ USED ______ CASING THEN ______

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4 Soft	30 + Hard
10-30	Med Dense	4-8 M/Stiff	
30-50	Dense	8-15 Stiff	
50 +	Very Dense	15-30 V-Stiff	

SUMMARY
Earth Boring ______
Rock Coring ______
Samples ______

HOLE NO D-13

Am...

SHEET	1 OF 4
DATE	
HOLE NO.	B-14
LINE & STA.	
OFFSET	
SURF. ELEV.	24.64 Mean Sea Level

TO Comm. ...

...VECT NAME ... ...aintree, Mass.

...ORT SEN...

SAMPLES ...

	Date	Time
START	8/29/75	a.m. p.m.
COMPLETE	9/8/75	a.m. p.m.
TOTAL HRS		
BORING FOREMAN	Long	
INSPECTOR		
SOILS ENGR.		

At ...

At ...

LOCATI...

DEPTH		SOIL IDENTIFICATION ...udation, Type of soil etc. ...hardness, Drilling ...reaks and unusual conditions.	SAMPLE No.	Pen	Rec.
		... SAND, Gravel ...TILL	1	12"	10"
			2	12"	12"
		...SAND & Silt ... gravel			
			3	12"	12"
			4	12"	12"
			5	12"	10"
			6	12"	10"
			7	12"	12"
			8	12"	12"

SUMMARY

Earth Boring	89'
Rock Coring	35'
Samples	15

HOLE NO. B-14

American Drilling & Boring Co., Inc.
100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 2 OF 4
DATE
HOLE NO. D-14
LINE & STA.
OFFSET
SURF. ELEV.

TO ______ ADDRESS ______
JECT NAME ______ LOCATION ______
ORT SENT TO ______ PROJ. NO. ______
SAMPLES SENT TO ______ OUR JOB NO. ______

GROUND WATER OBSERVATIONS
At ______ after ______ Hours
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		
BORING FOREMAN		
INSPECTOR		
SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	SAMPLE Pen	SAMPLE Rec
	61	40.5'-41.5'	D	157	moist		Brown fine-medium SAND, some	9	12"	12"
	71			(300#)	very		silt, lirrle fine gravel			
	63?				compact		Boulders			
	59?									
	130?					45'				
	65?	45.4'-46.5'	D	179	moist			10	12"	10"
	70?			(300#)	very					
	60				dense		Brown fine-coarse SAND & fine			
	73						gravel, little silt, Boulders			
	81									
	90	50.5'-51.5'	D	184	"			11	12"	11"
	100			(300#)						
	110									
	120									
	162					55'				
	63	55.5'-56.5'	D	183	"		Brown fine-coarse SAND &	12	12"	10"
	60			(300#)			Gravel, trace silt, Boulders			
	48									
	71									
	110					60'				
	55	60.5'-61.5'	D	161				13	12"	9"
	71			(300#)	moist		Brown fine-medium SAND, some			
	64				very		silt, lirrle fine-medium			
	87				compact		gravel, Boulders			
	90?									
	61	65.5'-66.5'	D	180				14	12"	8"
	71			(300#)	"					
	110									
	120									
	90?									
	72									
	61									
	141?									
	210									
	300?					75'				
	63?	75.5'-76.5'	D	160	moist		Brown fine-medium SAND, little	15	12"	9"
	71?			(300#)	very		silt; trace fine gravel,			
	69?				dense		Boulders			
	110									
	140									

GROUND SURFACE TO ______ USED ______ CASING THEN ______

Sample Type
D Dry C Cored W Washed
UP Undisturbed Piston
TP Test Pit A Auger V Vane Test
UT Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4 Soft	30 + Hard
10-30	Med Dense	4-8 M/Stiff	
30-50	Dense	8-15 Stiff	
50 +	Very Dense	15-30 V-Stiff	

SUMMARY
Earth Boring
Rock Coring
Samples

HOLE NO. 14

American Drilling & Boring Co., Inc.
100 WATER STREET EAST PROVIDENCE, R. I

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 3 OF 4
DATE ______
HOLE NO. D-14
LINE & STA. ______
OFFSET ______
SURF. ELEV. ______

TO ______ ADDRESS ______
PROJECT NAME ______ LOCATION ______
REPORT SENT TO ______ PROJ. NO. ______
SAMPLES SENT TO ______ OUR JOB NO. ______

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR		Date	Time
At ______ after ______ Hours	Type				START		a.m. p.m.
At ______ after ______ Hours	Size I.D.				COMPLETE		a.m. p.m.
	Hammer Wt.			BIT	TOTAL HRS.		
	Hammer Fall				BORING FOREMAN		
					INSPECTOR		
					SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	SAMPLE Pen	SAMPLE Rec.
	48									
	73						Brown fine-medium SAND, little silt, trace fine gravel, Boulders			
	91									
	110									
	150					85'				
	61	85.5'-86.5'	D	200	moist		Brown SILT & very fine sand layers w/little reddish fine to coarse sand & fine gravel	16	12"	15"
	72			(300#)	hard					
	125									
	161					89'				
		89'-94'	C		7			C1	60"	57"
					8					
					9					
					11					
					12					
		94'-99'	C		11			C2	60"	52"
					10					
					9		Pink-gray GRANITE - hard & fractured			
					10					
					12					
		99'-104'	C		14			C3	60"	38"
					13					
					15					
					18					
					12					
		104'-109'	C		14			C4	60"	48"
					13					
					15					
					14					
					16					
		109'-114'	C		15			C5	60"	36"
					17		(lost 45' BW casing)			
					16					
					18					
					20					
		114'-119'	C		18			C6	60"	48"
					17					
					16					
					15					
					17					
		119'-124'	C		19			C7	60"	43"

USED ______ CASING THEN ______

Sample Type	Proportions Used	140 lb Wt x 30" fall on 2" O.D. Sampler		SUMMARY
		Cohesionless Density	Cohesive Consistency	
	trace 0 to 10%	0-10 Loose	0-4 Soft 30 + Hard	Earth Boring ______
	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff	Rock Coring ______
	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples ______
	and 35 to 50%	50 + Very Dense	15-30 V Stiff	HOLE NO. D-14

American Drilling & Boring Co., Inc.
100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 4 OF 4
DATE
HOLE NO. D-14
LINE & STA.
OFFSET
SURF. ELEV.

TO
PROJECT NAME
REPORT SENT TO
SAMPLES SENT TO
ADDRESS
LOCATION
PROJ. NO.
OUR JOB NO.

GROUND WATER OBSERVATIONS
At ______ after ______ Hours
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		

BORING FOREMAN
INSPECTOR
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	SAMPLE Pen	SAMPLE Rec.
					18					
					19					
					17					
					20	124'				
							Bottom of Boring- 124'			

GROUND SURFACE TO ______ USED ______ CASING THEN ______

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
T = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY
Earth Boring ______
Rock Coring ______
Samples ______

HOLE NO 14

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1
DATE
HOLE NO. D-15
LINE & STA.
OFFSET
SURF. ELEV. 29.7

TO Comm.of Mass.-M.D.C.Engr.Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR		Date
At 7' after 1/4 Hours	Rods "AW" Type	BW	S/S	ADX3	START	9/2/75
	Size I.D.	2½"	1-3/8"		COMPLETE	9/4/75
At ______ after ______ Hours	Hammer Wt.	300#	140#	BIT	TOTAL HRS.	
	Hammer Fall	24"	30"	dia	BORING FOREMAN	Allen
					INSPECTOR	
					SOILS ENGR.	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	Sample No.	Pen	Rec
	4	0'-1'	D	16	dry		Brown fine-medium SAND, some	1	[illegible]	
	10				medium	2'	silt, little fine-medium gravel			
	16				dense					
	16						Brown fine-coarse SAND, some			
	22						fine-medium gravel, some silt			
	1	5'-6'	D	17	moist			2	[illegible]	
	14				medium					
	44				dense					
	50									
	41									
	10	10'-11'	D	53	moist			3	[illegible]	
	12				very					
	44				dense	13'	Top of Rock			
		13'-17'	C				(8 mins. drilling time)	C1	[illegible]	
		17'-21'	C					C2	48"	
		21'-23'6"	C				Pinkish-gray GRANITE	C3	30"	
		23'6"-25'	C				hard, fractured & seamy	C4	18"	
		25'-29½'	C					C5	54"	
		29½'-34½'	C					C6	60"	
		34½'-38½'	C					C7	48"	
		38½'-43½'	C					C8	60"	
		43½'-48'	C			48'		C9	54"	
							Bottom of Boring- 48'			

GROUND SURFACE TO 13' USED BW CASING THEN Cored rock to 48'

Sample Type	Proportions Used		140 lb Wt x 30" fall on 2" O.D. Sampler			
D=Dry C=Cored W=Washed			Cohesionless Density		Cohesive Consistency	
UP=Undisturbed Piston	trace	0 to 10%	0-10	Loose	0-4 Soft	30 + Hard
TP=Test Pit A=Auger V=Vane Test	little	10 to 20%	10-30	Med Dense	4-8 M/Stiff	
UT=Undisturbed Thinwall	some	20 to 35%	30-50	Dense	8-15 Stiff	
	and	35 to 50%	50 +	Very Dense	15-30 V-Stiff	

HOLE NO. D-15

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg ______

Bit # ______ Ftg ______

SHEET 1 OF 2
DATE
HOLE NO. D-16
LINE & STA.
OFFSET
SURF. ELEV. 11.10 Mean Sea Lev.

TO Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 9' after 1/4 Hours

At ______ after ______ Hours

Rods-"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	AXD3
Size I.D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	Dia.

	Date	Time
START	8/28/75	a.m. p.m.
COMPLETE	9/2/75	a.m. p.m.
TOTAL HRS.		
BORING FOREMAN	K. Allen	
INSPECTOR	G. Seladon	
SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	1	0'-1'	D	26	Dry/m		Brown fine SAND, Gravel, trace	1	12"	3"
	1				dense		Ash & Brick, Fill			
	1					3'				
	4				Wet		Gray SILT & Clay, trace of			
	5				very		peat fiber			
	2	5'-6'	D	2	soft	6.5'		2	12"	12"
	2									
	4									
	4									
	4									
	7	10'-11'	D	10	Wet		Brown CLAY, some silt &	3	12"	12"
	6				stiff		fine sand layers			
	8									
	8									
	8				Wet					
	18	15'-16'	D	4	soft	16.5'		4	12"	12"
	26									
	45									
	40									
	26									
	18	20'-21'	D	24	Wet		Brown coarse to fine GRAVEL,	5	12"	12"
	26				medium		some fine to coarse sand,			
	34				dense		little silt			
	36									
	42					25'				
	22	25'-26'	D	64	Wet		Gray fine to coarse SAND,	6	12"	12"
	34				very		some fine to medium gravel,			
	54				dense		some silt			
	45									
	56									
	42	30'-31'	D	32	Wet			7	12"	12"
	15				dense					
	18									
	16									
	13					35'				
	12	35'-36'	D	67	Wet		Gray coarse to fine GRAVEL	8	12"	12"
	14			(300# Wt.)	very		& fine to coarse Sand, some			
	14				dense		silt			
	16									
	82					40'				

GROUND SURFACE TO 41' USED BW CASING THEN Cored to 76'

Sample Type
D-Dry C-Cored W-Washed
UP-Undisturbed Piston
TP-Test Pit A-Auger V-Vane Test
UT-Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY
Earth Boring 41'
Rock Coring 35'
Samples 9

HOLE NO D-16

American Drilling & Boring Co., Inc.
100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 2 OF 2
DATE ______
HOLE NO. D-16
LINE & STA. ______
OFFSET ______
SURF. ELEV. ______

TO ______ | ADDRESS ______
[PRO]JECT NAME ______ | LOCATION ______
[RE]PORT SENT TO ______ | PROJ. NO. E-444
SAMPLES SENT TO ______ | OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS
At ______ after ______ Hours
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		

BORING FOREMAN ______
INSPECTOR ______
SOILS ENGR. ______

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	SAMPLE Pen	SAMPLE Rec.
	55	40'-41'	D	122	W/v/d	41'	Gray weathered SHALE & Silt	9	12"	12"
		41'-46'	C					C1	60"	20"
		46'-51'	C				Gray SHALE, medium hard, fractured & seamy	C2	60"	30"
		51'-54'	C					C3	36"	11"
		54'-59'	C					C4	60"	30"
		59'-64'	C					C5	60"	58"
		64'-69'	C					C6	60"	60"
		69'-74'	C					C7	60"	58"
		74'-76'	C				(layers of Sandstone)	C8	24"	24"
						76'	Bottom of Boring 76'			

GROUND SURFACE TO ______ USED ______ " CASING THEN ______

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY
Earth Boring ______
Rock Coring ______
Samples ______

HOLE NO D-16

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 2 OF 3
DATE
HOLE NO. D-17
LINE & STA.
OFFSET
SURF. ELEV.

TO
[...]JECT NAME
[...]PORT SENT TO
SAMPLES SENT TO

ADDRESS
LOCATION
PROJ. NO. E-444
OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR
At ______ after ______ Hours	Type			
	Size I.D.			
At ______ after ______ Hours	Hammer Wt.			BIT
	Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		
BORING FOREMAN		
INSPECTOR		
SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	21	40'-41'	D	33	Wet		Brown fine to coarse GRAVEL,	10	12"	6"
	37				dense		some fine to coarse sand,			
	46						trace of silt			
	52									
	55									
	20	45'-46'	D	31	"			11	12"	4"
	25									
	32									
	42									
	44									
	40	50'-51'	D	34	"			12	12"	4"
	37									
	48									
	44									
	48									
	36	55'-56'	D	89	Wet			13	12"	12"
	45				very					
	47				dense	58'				
	66									
	56									
	50	60'-61'	D	97	Wet		Gray CLAY & Silt, little fine	14	12"	12"
	46				very		to coarse sand, little fine			
	55				dense		to medium gravel			
	70									
	77									
	40	65'-66'	D	90	"			15	12"	12"
	32									
	40									
	40						DX open end AW rod 140#-30"			
		@ 69.5'	DX	Refusal		69.5'				
		69.5'-72.6'	C				Gray SHALE, medium hard,	C1	37"	37"
							fractured & seamy			
		72.6'-74'	C					C2	17"	17"
		74'-77.2'	C					C3	38"	38"
							(Coring Time - 4 Min/Ft.)			
		77.2'-81'	C					C4	46"	46"

GROUND SURFACE TO ______ USED ______ " CASING: THEN

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4 Soft	30 + Hard
10-30	Med Dense	4-8 M/Stiff	
30-50	Dense	8-15 Stiff	
50 +	Very Dense	15-30 V-Stiff	

SUMMARY
Earth Boring ______
Rock Coring ______
Samples ______

HOLE NO. D-17

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 3 OF 3
DATE
HOLE NO. D-17
LINE & STA.
OFFSET
SURF. ELEV.

TO ______ ADDRESS ______
...JECT NAME ______ LOCATION ______
...PORT SENT TO ______ PROJ. NO. E-444
SAMPLES SENT TO ______ OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At ______ after ______ Hours

At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

	Date	Time
START		a.m. p.m.
COMPLETE		a.m. p.m.
TOTAL HRS.		

BORING FOREMAN
INSPECTOR
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	SAMPLE Pen	SAMPLE Rec.
		81'-84'	C				Gray SHALE, medium hard, fractured & seamy	C5	36"	36"
		84'-88'	C					C6	48"	48"
		88'-92'	C					C7	48"	48"
		92'-97'	C					C8	60"	60"
		97'-101'	C					C9	48"	48"
							(Coring Time - 4 Min/Ft.)			
		101'-104.5'	C					C10	54"	54"
						104.5'	Bottom of Boring 104.5'			

GROUND SURFACE TO ______ USED ______ " CASING: THEN ______

Sample Type
D Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density
0-10 Loose
10-30 Med Dense
30-50 Dense
50 + Very Dense

Cohesive Consistency
0-4 Soft
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff
30 + Hard

SUMMARY
Earth Boring ______
Rock Coring ______
Samples ______

HOLE NO D-17

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET	1 OF 1
DATE	
HOLE NO.	D-18
LINE & STA.	
OFFSET	
SURF. ELEV.	7.42 Mean Sea Level

Comm. of Mass. - M.D.C. Engr. Div. ADDRESS Boston, Mass.

PROJECT NAME Town Brook Flood Control LOCATION Quincy/Braintree, Mass.

REPORT SENT TO above PROJ. NO. E-444

SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 4' after 1/4 Hours

At ______ after ______ Hours

Rods-"AW"	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	8/25/75	a.m. p.m.
COMPLETE	8/25/75	a.m. p.m.
TOTAL HRS.		
BORING FOREMAN	K. Allen	
INSPECTOR	G. Selados	
SOILS ENGR.		

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	3	0'-1'	D	6	Moist loose		Loam - Brown fine to medium SAND, little fine to medium gravel, trace of silt, Fill	1	12"	5"
	5									
	6									
	9									
	9					5'				
	6	5'-6'	D	6	Wet loose		Brown fine to medium SAND & Silt, little fine to medium gravel, Fill	2	12"	7"
	6									
	7					8'				
	5									
	4				Wet very soft		Gray Organic SILT, trace of shells, trace of fine sand			
	4	10'-11'	D	1				3	12"	10"
	4									
	3					13'				
	22	13'-14'	D	21				-	12"	8"
	34									
	14	15'-16'	D	31	Wet dense		Gray fine to medium SAND & Silt, some fine to coarse gravel	4	12"	3"
	16									
	46									
	50									
		19'-20'	D	34	"	20'		5	12"	10"
							Bottom of Boring 20'			

GROUND SURFACE TO 19' USED BW CASING: THEN S/S to 20'

Sample Type
D: Dry C: Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit A: Auger V: Vane Test
UT: Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4 Soft	30 + Hard
10-30	Med Dense	4-8 M/Stiff	
30-50	Dense	8-15 Stiff	
50 +	Very Dense	15-30 V-Stiff	

SUMMARY
Earth Boring 20'
Rock Coring ______
Samples 5

HOLE NO D-18

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______

Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE
HOLE NO. D-19
LINE & STA.
OFFSET
SURF. ELEV. 66.21 MSL

TO Comm. of Mass. MDC- Engr.Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy-Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS
At 1' after 1/2 Hours
No casing
At ______ after ______ Hours

Rods-AW	CASING	SAMPLER	CORE BAR
Type	BW	S/S	AXD-3
Size I.D.	2-1/2"	1-3/8"	1-1/8"
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	Diamond

	Date	Time
START		a.m. p.m.
COMPLETE	10/10/75	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN C. Lenting
INSPECTOR K. Mirochnick
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	P	0.5'-1.5'	D	PUSHED	wet		Brown PEAT	1	12"	9"
	P				soft					
	2					3'-0"				
	19									
	25				wet					
	17	5'-6'	D	23	medium		Brown fine to coarse SAND, some	2	12"	7"
	35				dense		silt, some fine to coarse gravel			
	41									
	46									
	50				wet					
	28	10'-11'	D	32	dense			3	12"	9"
	65									
	105				min/ft	13.0'	Top of Rock 13'			
		13'-18'	C		3			C1	60"	30"
					5		Pink GRANITE			
					7		Fractured & hard			
					8					
					9					
		18'-23'	C		6			C2	60"	28"
					8					
					12					
					13					
					15	23.0'				
							Bottom of Boring 23.0'			

GROUND SURFACE TO 13' USED BW CASING THEN C to 23'

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY
Earth Boring 13'
Rock Coring 10'
Samples 3

HOLE NO D-19

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg. ______
Bit # ______ Ftg. ______

SHEET 1 OF 1
DATE
HOLE NO. D-21
LINE & STA.
OFFSET
SURF. ELEV. 84.15 MSL

TO Comm. of Mass. MDC -Engr. Div. | ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control | LOCATION Quincy-Braintree, Mass.
REPORT SENT TO above | PROJ. NO. E-444
SAMPLES SENT TO " | OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS

At 10' in casing after ___ Hours
Piezometer-1st @ 39' 2nd @ 18'
Riser pipe w/ cap & lock
At ______ after ______ Hours
Also bentonite balls & O. Sand

Rods-AW	CASING	SAMPLER	CORE BAR
Type	HW & BW	S/S	
Size I.D.	3-1/2 & 2-1/2"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	10/10/75	a.m. p.m.
COMPLETE	10/15/75	a.m. p.m.

TOTAL HRS.
BORING FOREMAN R. V. Long
INSPECTOR Pat T.
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
HW	6	0'-2'	D	4	dry		Brown fine loamy SAND, little	1	24"	10"
cas-	8			5	loose	2.0'	fine gravel, FILL			
ing	10	2'-4'	D	13				2	24"	19"
to	14			12	moist					
20'	19	4'-6'	D	19	medium		Light brown fine to medium SAND,	3	24"	13"
	21			19	dense		Little fine gravel, trace silt, FILL			
	29	6'-8'	D	17				4	24"	18"
	30			16						
	29	8'-10'	D	28				5	24"	9"
	30			29						
	31	10'-12'	D	29				6	24"	13"
	33			29						
	34	12'-14'	D	25				7	24"	14"
	35			27		14.0'				
	33	14'-16'	D	28	wet			8	24"	13"
	34			26	medium		Gray-brown coarse to fine SAND,			
	36	16'-18'	D	22	dense		Some fine to coarse gravel,	9	24"	15"
	35			24		18.0'	Trace silt, FILL			
	36	18'-20'	D	18	"		Gray fine to coarse SAND and	10	24"	6"
	15			18		20.0'	gravel, trace silt			
BW	10	20'-22'	D	13				11	24"	7"
to	9			13			Gray-brown coarse to fine SAND,			
40'	8	22'-24'	D	13	"		Some silt, some fine to coarse	12	24"	8"
	9			14			gravel			
	10	24'-26'	D	14				13	24"	7"
	9			14						
	10	26'-28'	D	13				14	24"	6"
	10			15		28.0'				
	9	28'-30'	D	15	"		Brown fine to coarse SAND &	15	24"	5"
	9			14		30.0'	gravel, Little silt			
	10	30'-32'	D	22	"		Gray-brown fine SAND & gravel,	16	24"	8"
	12			23			Some silt, boulders and weathered			
	10	32'-34'	D	28			shale	17	24"	10"
	15			30		34.0'				
	39	34'-36'	D	60	moist		Gray fine SAND, silt and weathered	18	24"	8"
	64			78	very		shale, trace fine gravel			
	89	36'-38'	D	76	dense			19	24"	9"
	110			112		38.0'				
	141	38'-39'	D	130	"		Dark gray weathered SHALE	20	12"	8"
	131	39'-40'	D	152		40.0'	Bottom of Boring 40.0'	21	12"	6"

GROUND SURFACE TO 40' USED HW & BW CASING THEN Bot. of boring

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY
Earth Boring 40'
Rock Coring
Samples 21

HOLE NO. D-21

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ______ Ftg ______
Bit # ______ Ftg ______

SHEET 1 OF 1
DATE
HOLE NO. D-22
LINE & STA.
OFFSET
SURF. ELEV. 85.58 MSL

TO Comm. of Mass. MDC-Engr. Div. ADDRESS Boston, Mass.
PROJECT NAME Town Brook Flood Control LOCATION Quincy-Braintree, Mass.
REPORT SENT TO above PROJ. NO. E-444
SAMPLES SENT TO " OUR JOB NO. 6-54

GROUND WATER OBSERVATIONS
At 26' in casing after ____ Hours
Piezometer - 1st @ 39'
2nd @ 29'
At ____ after ____ Hours
w/Riser pipe, lock, bentonite balls & O. sand

Rods-AW

	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2-1/2"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	10/15/75	a.m. p.m.
COMPLETE	10/17/75	a.m. p.m.

TOTAL HRS.
BORING FOREMAN R. V. Long
INSPECTOR P. Carroll
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	5	0'-2'	D	7	dry		Brown loamy fine SAND, little	1	24"	10"
	6			10	loose	2.0'	fine gravel, FILL			
	9	2'-4'	D	13	dry			2	24"	14"
	10			15	medium		Light brown fine SAND, little			
	12	4'-6'	D	23	dense		fine gravel, trace silt, FILL	3	24"	18"
	10			29						
	13	6'-8'	D	20				4	24"	14"
	14			28						
	10	8'-10'	D	19				5	24"	16"
	13			22						
	13	10'-12'	D	23	"			6	24"	18"
	11			24						
	13	12'-14'	D	21				7	24"	18"
	8			25						
	9	14'-16'	D	17	moist			8	24"	15"
	8			17	medium					
	10	16'-18'	D	15	dense			9	24"	13"
	11			17						
	9	18'-20'	D	13				10	24"	10"
	28			13		20.0'				
	30	20'-22'	D	34	moist			11	24"	12"
	29			32	dense		Brown fine to medium SAND,			
	30	22'-24'	D	35			Some fine to medium gravel,	12	24"	10"
	31			33		24.0'	Trace silt, boulders			
	21	24'-26'	D	50				13	24"	9"
	20			48	wet		Brown fine to coarse SAND and			
	19	26'-28'	D	50	dense		gravel, small boulders, trace silt	14	24"	6"
	18			51						
	17	28'-30'	D	15	wet			15	24"	5"
	10			13	medium	30.0'				
	9	30'-32'	D	9	dense		Brown fine to coarse SAND and	16	24"	6"
	10			10			gravel, some silt, trace shale frag-			
	9	32'-34'	D	9	"		ments	17	24"	7"
	9			11		34.0'				
	10	34'-36'	D	17			Gray-brown fine to coarse SAND,	18	24"	9"
	10			18	"		GRAVEL, SILT & SHALE			
	11	36'-38'	D	17				19	24"	10"
	32			18		38.0'				
	36	38'-40'	D	68	~~moist~~ very		Gray weathered SHALE	20	24"	13"
	49			119	dense	40.0'	Bottom of Boring 40.0'			

GROUND SURFACE TO 40' USED BW CASING: THEN bot. of boring

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler
Cohesionless Density
0-10 Loose
10-30 Med Dense
30-50 Dense
50 + Very Dense

Cohesive Consistency
0-4 Soft
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff
30 + Hard

SUMMARY
Earth Boring 40'
Rock Coring
Samples 20

HOLE NO D-22

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

Bit # ____ Ftg ____

Bit # ____ Ftg ____

Comm. of Mass. MDC-Engr. Div. — Boston, Mass.

SHEET	1 OF 1
DATE	
HOLE NO.	D-23
LINE & STA.	
OFFSET	
SURF. ELEV.	61.40 MSL

PROJECT NAME: Town Brook Flood Control

ADDRESS / LOCATION: Quincy-Braintree, Mass.

REPORT SENT TO: above

PROJ. NO.: E-444

SAMPLES SENT TO: "

OUR JOB NO.: 6-54

GROUND WATER OBSERVATIONS

At 8'-4" after ____ Hours
14' of casing

At ____ after ____ Hours

Rods-AW

	CASING	SAMPLER	CORE BAR
Type	BW	S/S	
Size I.D.	2-1/2"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	10/21/75	a.m. p.m.
COMPLETE	10/21/75	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN: C. Koehler
INSPECTOR: P. Lydon
SOILS ENGR.:

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 12" on Sampler	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and any unusual conditions.	SAMPLE No.	Pen	Rec.
	1	0'-2'	D	2	dry	1.0'	Brown TOPSOIL	1A	12"	12"
	2			7	loose		Brown fine SAND, some silt, some	1B	12"	4"
	3	2'-4'	D	4		3.0'	fine to medium gravel	2	24"	6"
	3			7	dry					
	8	4'-6'	D	11	medium		Brown fine to medium SAND,	3	24"	17"
	13			14	dense		Little fine gravel, trace silt,			
	13	6'-8'	D	15	"		trace coarse sand(possible fill)	4	24"	15"
	13			12						
	4	8'-10'	D	16	"			5	24"	6"
	4			3						
	3	10'-12'	D	5	"			6	24"	7"
	9			8	wet					
	6	12'-14'	D	43	dense	13.5'		7A	12"	8"
	14			39			Dark brown fine to coarse SAND,	7B	6"	6"
		14'-16'	D	88	wet		Little silt, trace fine gravel(slightly	8	24"	14"
				85	very	14.0'	organic			
					dense		Brown fine to coarse SAND, some			
						16.0'	coarse to fine gravel, little silt			
							Installed piezometer at 15'			
							5' - 21/2" pipe w/ cap & lock 398			

GROUND SURFACE TO 14' USED BW CASING THEN S/S to 16'

Sample Type
D Dry C Cored W Washed
UP Undisturbed Piston
TP Test Pit A Auger V Vane Test
UT Undisturbed Thinwall

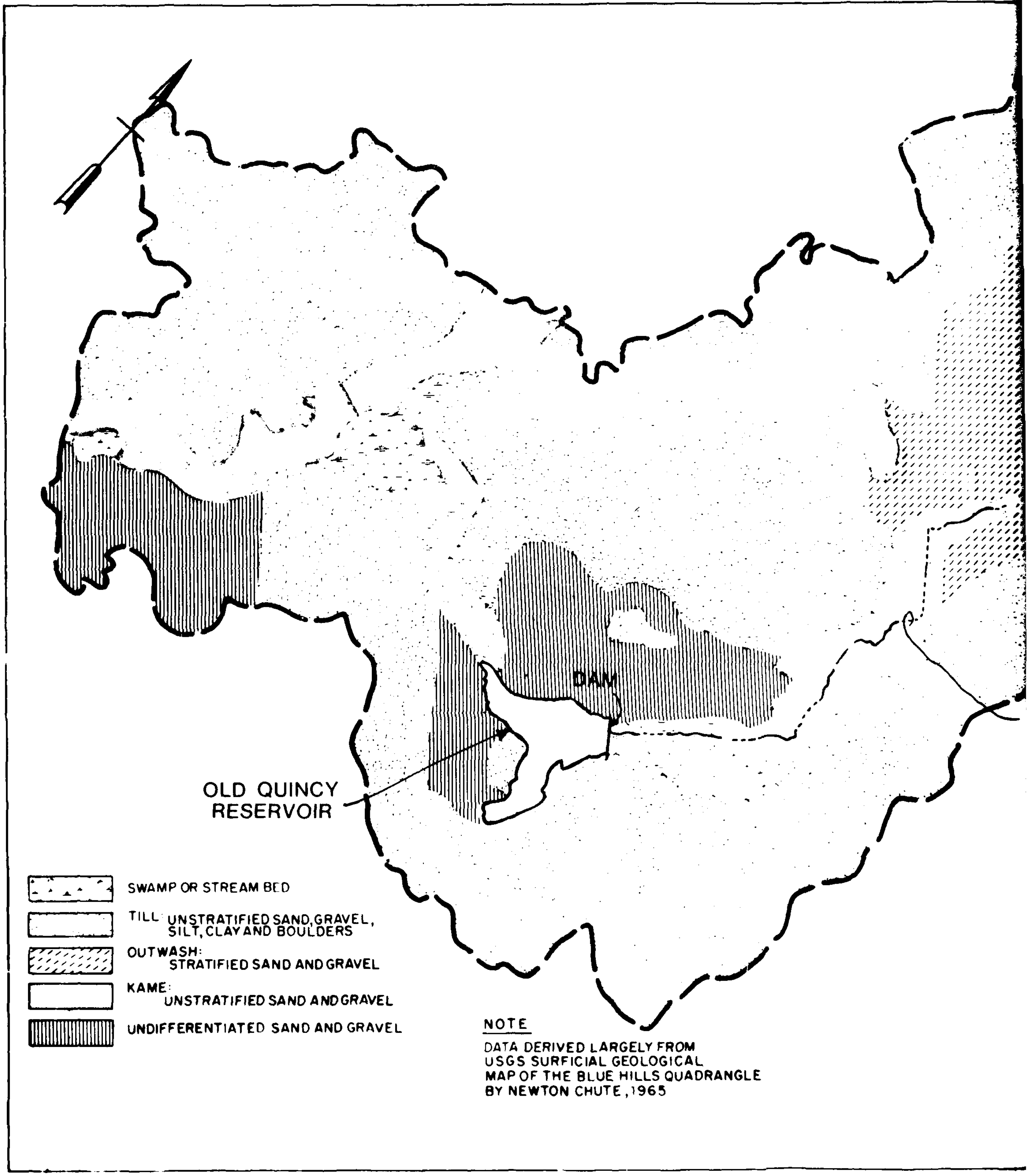
Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

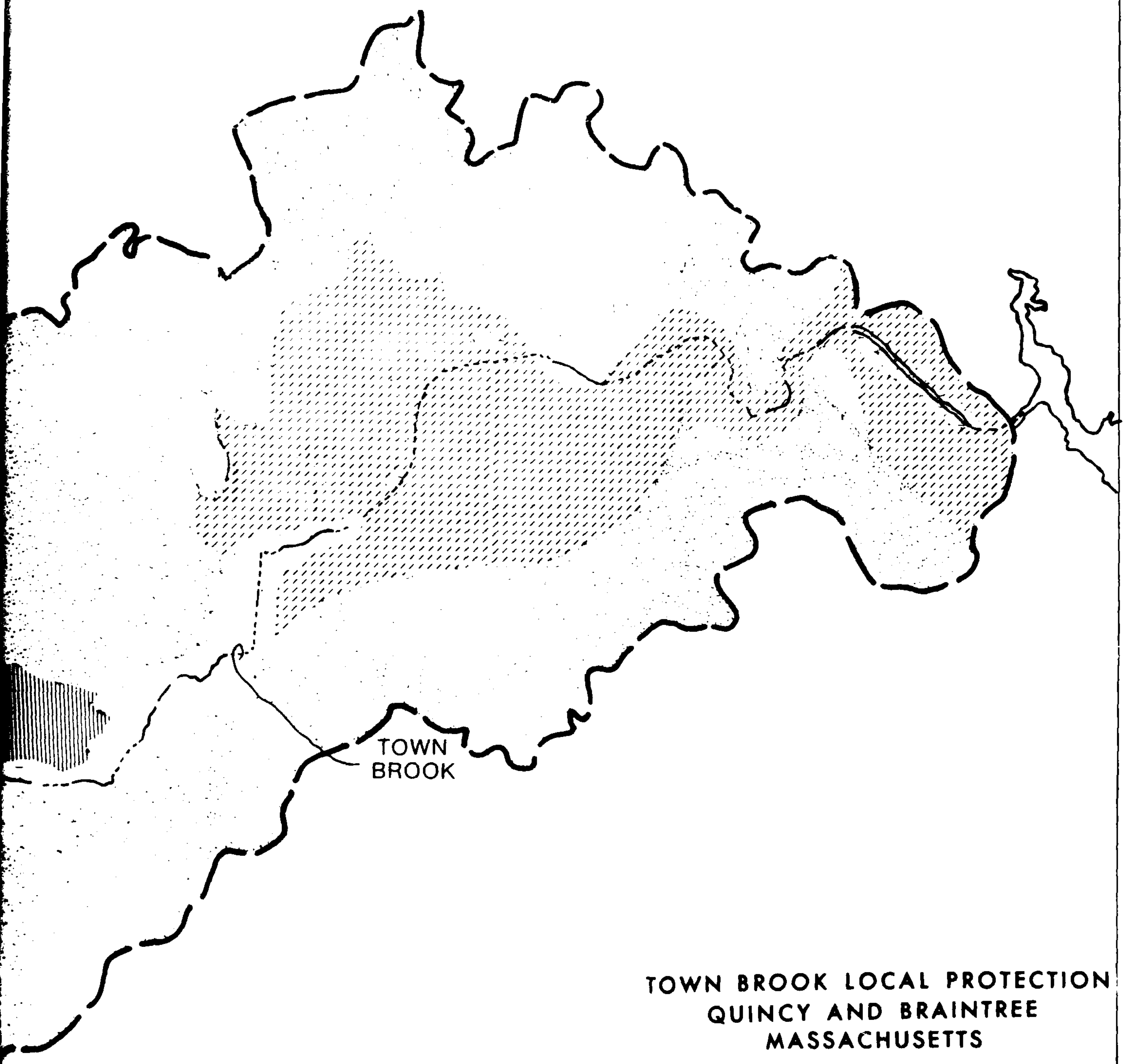
Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY
Earth Boring 16'
Rock Coring
Samples 8

HOLE NO D-23



DAM
OLD QUINCY
RESERVOIR
SWAMP OR STREAM BED
TILL: UNSTRATIFIED SAND, GRAVEL, SILT, CLAY AND BOULDERS
OUTWASH: STRATIFIED SAND AND GRAVEL
KAME: UNSTRATIFIED SAND AND GRAVEL
UNDIFFERENTIATED SAND AND GRAVEL
NOTE
DATA DERIVED LARGELY FROM
USGS SURFICIAL GEOLOGICAL
MAP OF THE BLUE HILLS QUADRANGLE
BY NEWTON CHUTE, 1965



TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

SURFICIAL GEOLOGY

NEW ENGLAND DIVISION

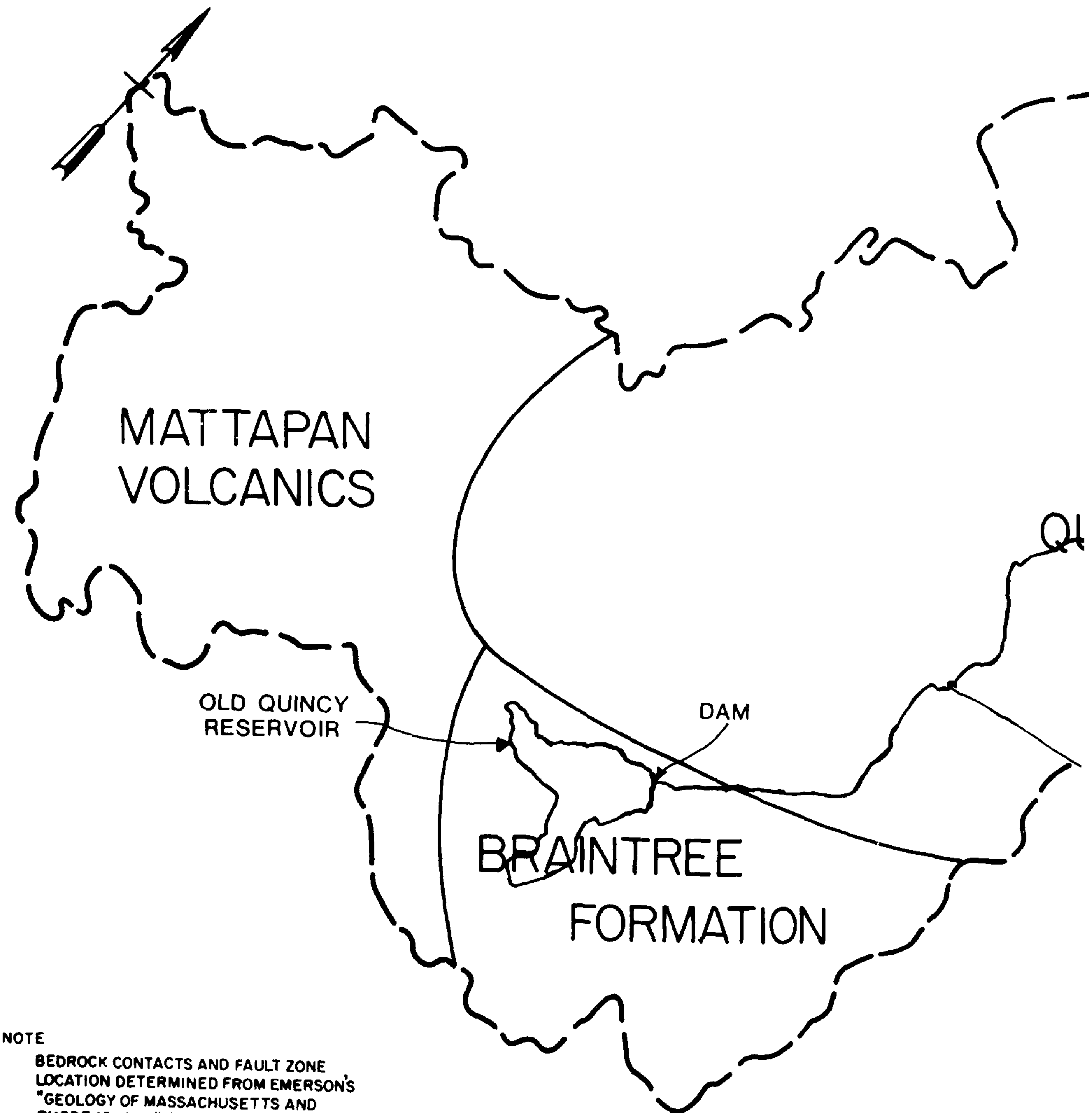
CORPS OF ENGINEERS

SEPTEMBER 1980

RANGLE

FIGURE E-1

2



NOTE

BEDROCK CONTACTS AND FAULT ZONE LOCATION DETERMINED FROM EMERSON'S "GEOLOGY OF MASSACHUSETTS AND RHODE ISLAND" (1917), AND UNPUBLISHED DATA FROM THE U.S. GEOLOGICAL SURVEY.

1

AD-A100 810 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
TOWN BROOK LOCAL PROTECTION, MASSACHUSETTS COASTAL STREAMS: FEA--ETC(U)
SEP 80

UNCLASSIFIED NL

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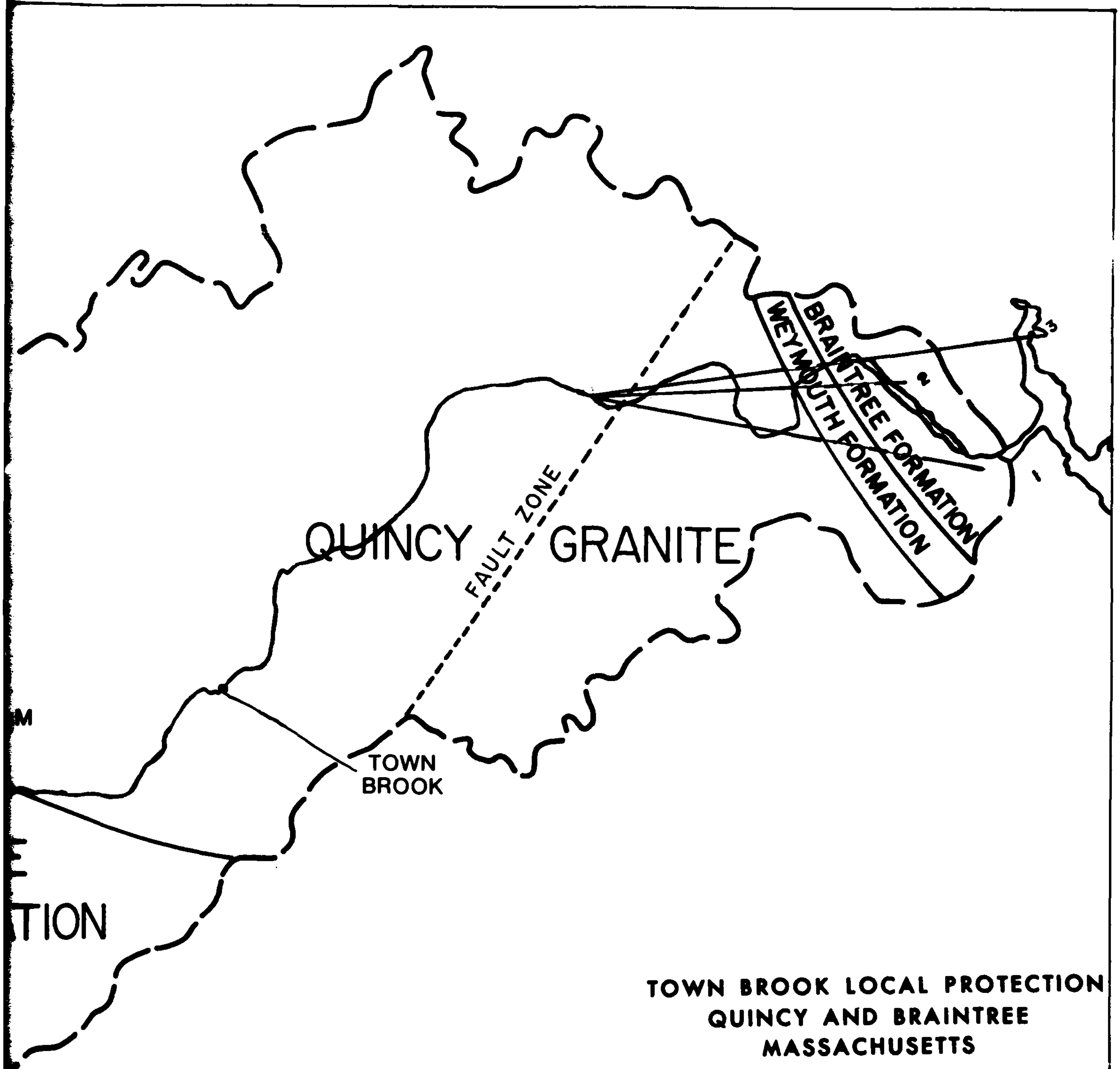


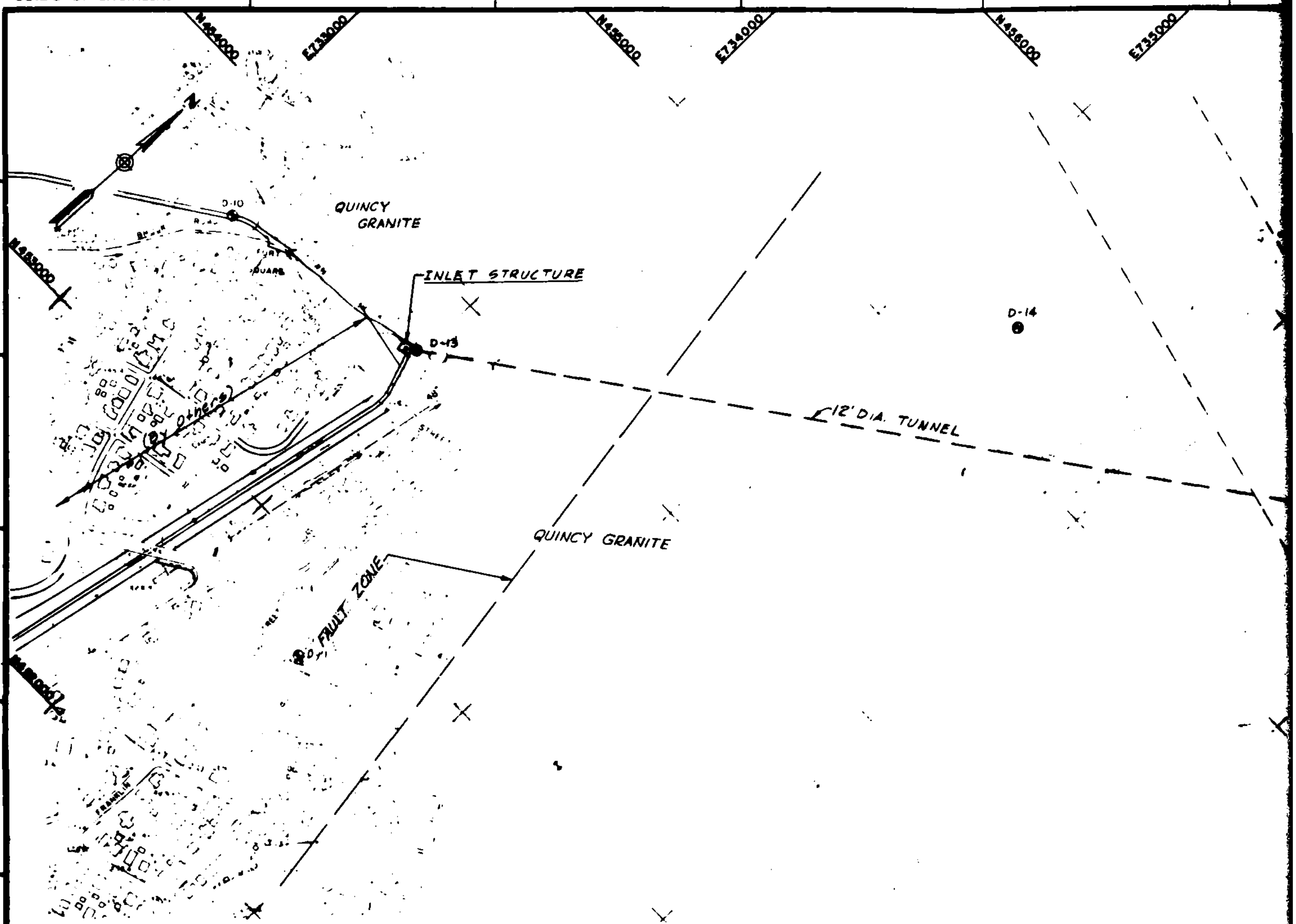
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

BEDROCK GEOLOGY

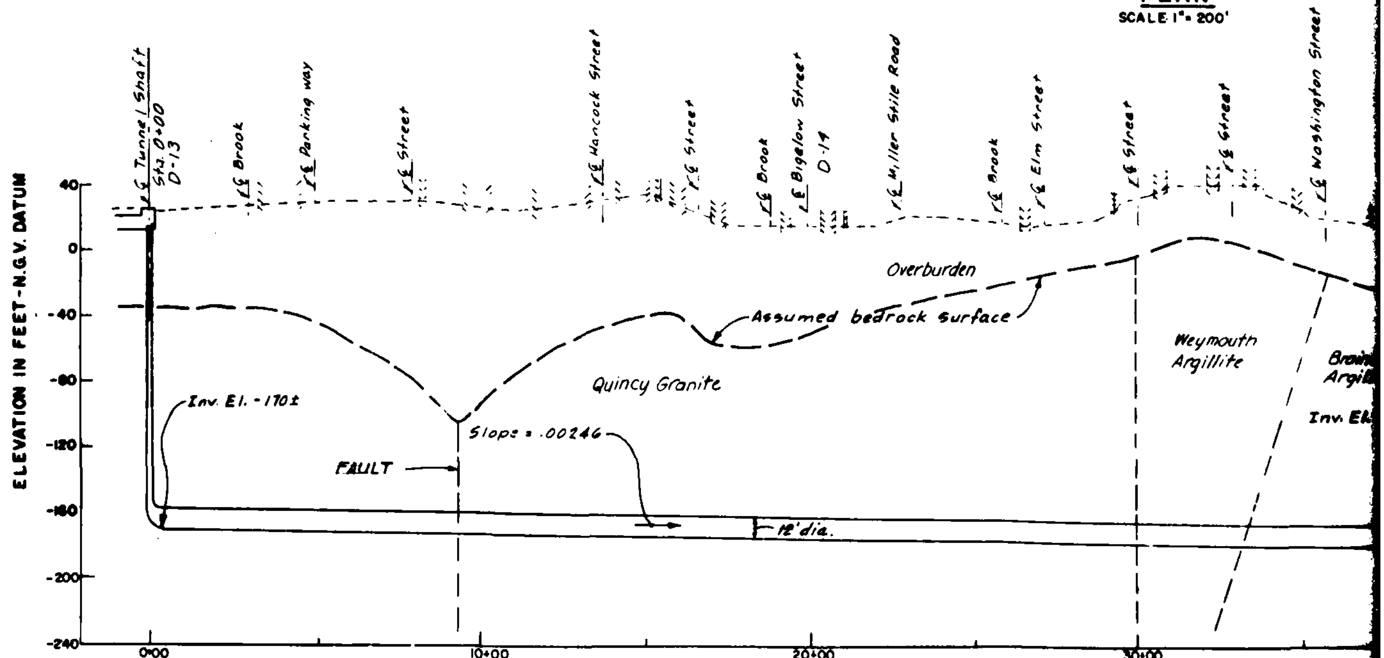
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER 1980

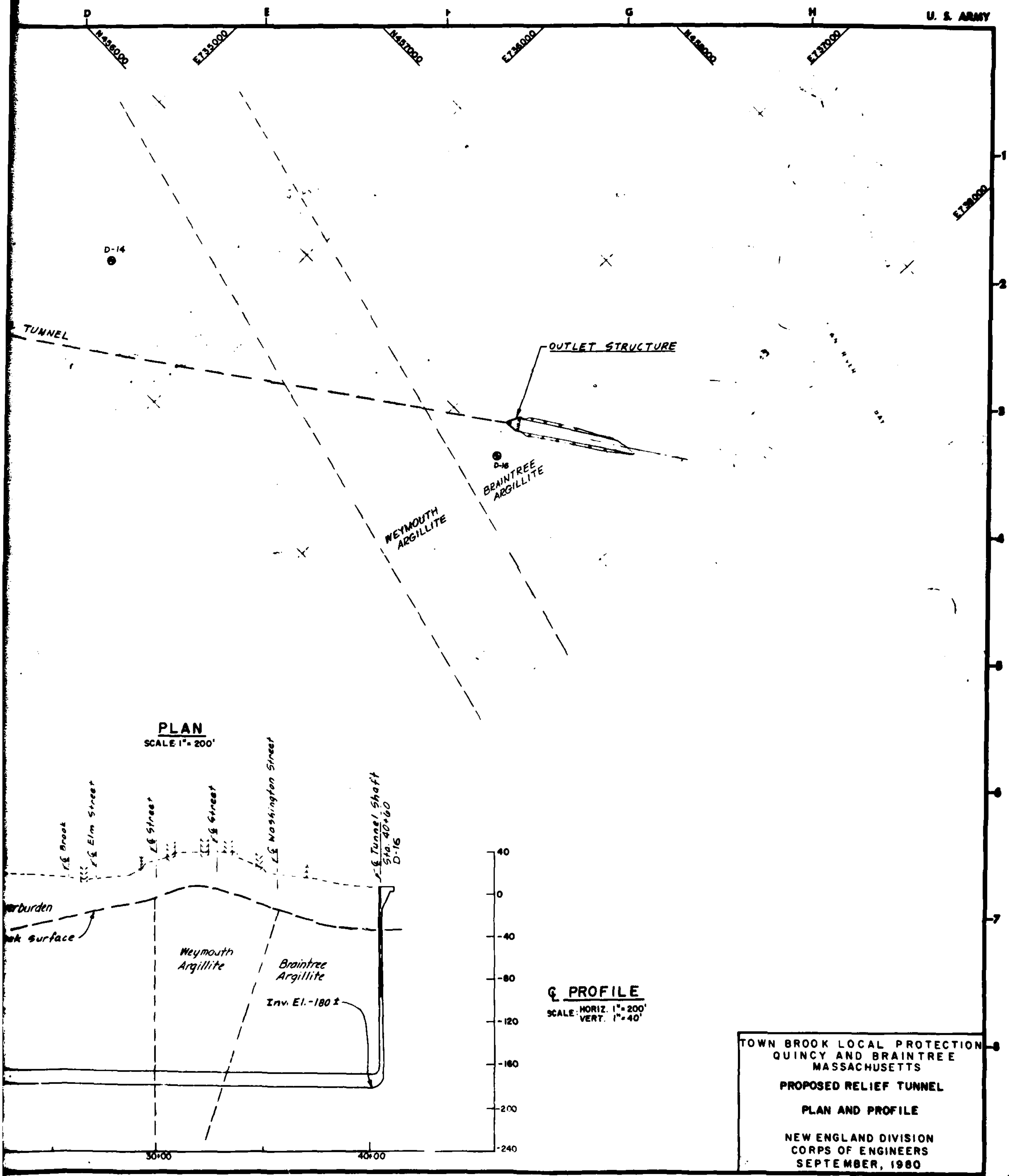
FIGURE E-2

CORPS OF ENGINEERS



PLAN
SCALE 1" = 200'





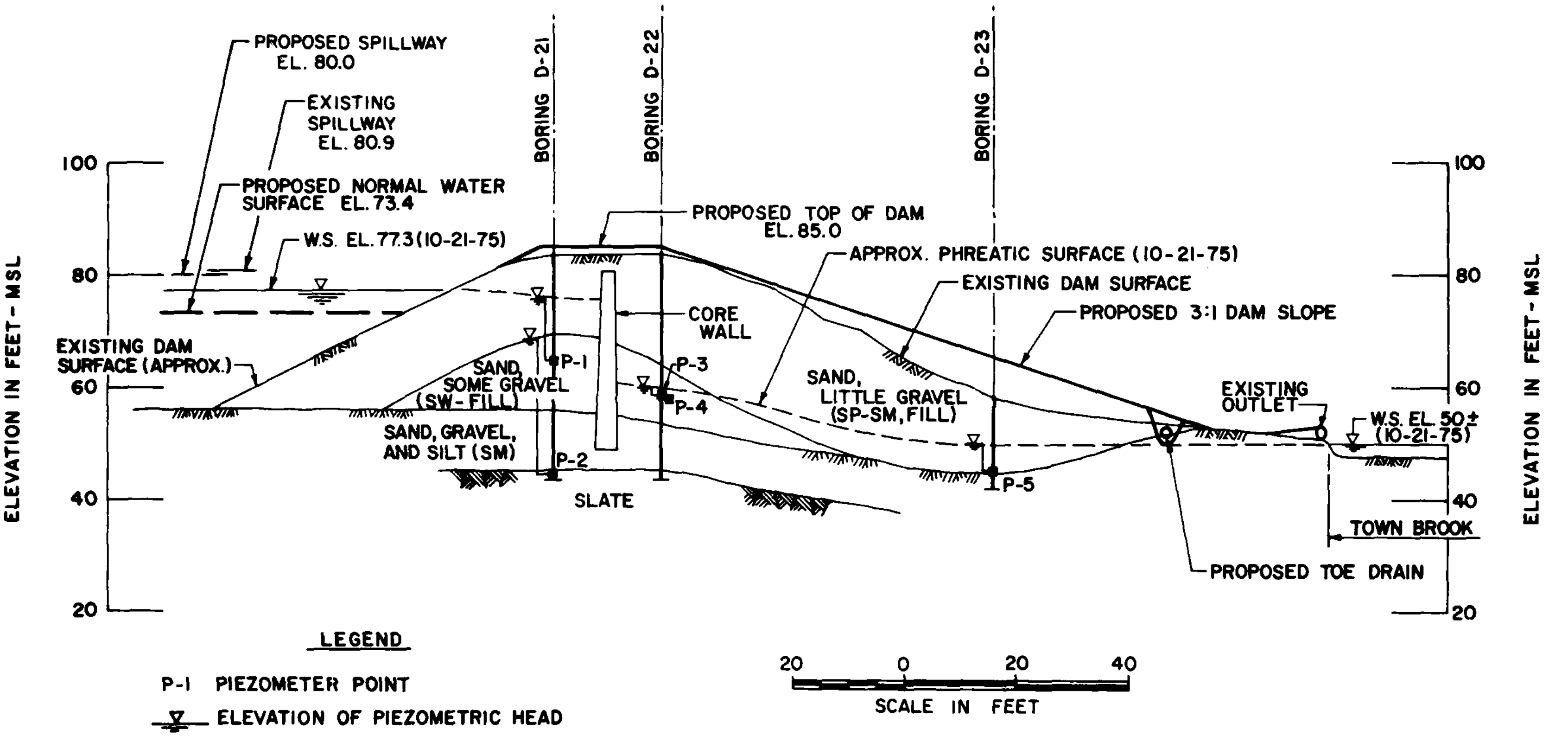
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

PROPOSED RELIEF TUNNEL

PLAN AND PROFILE

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

FIGURE E-3



TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

CROSS SECTION
BRAINTREE DAM

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER 1980

FIGURE E-4

Appendix F

Engineering Design and Cost Estimates

ENGINEERING DESIGN AND COST ESTIMATES

TABLE OF CONTENTS

Item	Page
A. TUNNEL PLAN	
1. Design	F1
a. General	F1
b. Old Quincy Reservoir Dam	F1
c. Relief Tunnel	F1
d. Town River Improvements	F2
2. Cost Estimates	F2
a. General	F2
b. Basis for Estimates	F9
c. Tunnel Costs	F9
d. Details of Estimates of First Cost	F10
B. NONSTRUCTURAL PLAN	
1. Summary	F11
2. Procedure	F11
a. Field Study	F11
b. Nonstructural Measures Investigated	F11
c. Nonstructural Alternatives Selected	F13
d. Flood Warning Plan	F15
3. Presentation of Results	F17

LIST OF TABLES

No.	Title	Page
F-1	Summary of Estimates First Costs	F3
F-2	Estimated First Construction Cost	F4
F-3	Summary of Estimated First Cost - Tunnel Plans	F8
F-4	Summary of Nonstructural Plan	F17
F-5	Cost Estimates	F18

LIST OF FIGURES

F1	Typical Tunnel Section
F2	Inlet Structure
F3	Outlet Structure
F4	Spillway Structure
F5	Southern Artery Culvert
F6	Utility Cell with Watertight Door
F7	Utility Cell with Stairs
F8	Typical Ringwall Section
F9	New Foundation Wall at Residential Structures - Slab on Grade
F10	Aluminum Closure Details
F11	3 Ft. Reinforced Concrete Wall at Commercial Structures
F12	Flood Warning Plan - Warning Dissemination Process

APPENDIX F

ENGINEERING DESIGN AND COST ESTIMATES

A. TUNNEL PLAN

1. Design.

a. General. Preliminary designs for the structural features of the project are based on the hydrologic and hydraulic studies presented in Appendix D. Several optional designs were considered for some features, and the most economical was selected for inclusion in the plan. The designs were developed to the point where quantities could be determined with sufficient accuracy to provide the basis for a reasonable estimate of the costs. Figures F1 through F5 present details of the structures included in the Tunnel Plan, the locations of which are shown on Figure 5 of the main report. The above figures present the designs upon which the cost estimates for the Tunnel Plan, are based.

b. Old Quincy Reservoir Dam. Investigations conducted for the Non-Federal Dam Inspection Report (November 1979) and those done for this report revealed the necessity for certain repairs and modifications at the dam. The inspection report also recommends that the seismic stability of the embankment be determined. This will be done in conjunction with the final design of the proposed project. The proposed modifications at the dam include the construction of an earthen dike, approximately 1,750 feet in length, adjacent to the west abutment; a new spillway and outlet structure; flattening of the downstream slope; repairs to the stone protection on the upstream slope and regrading of the top of the dam level at elevation +85.

Figure 7 of the main report is a plan of the reservoir and dam area that also shows cross sections of the existing dam and proposed dike and location of the proposed spillway and outlet structures. Two designs were considered for the proposed spillway and outlet structure. They consisted of a box type spillway, the details of which are shown on Figure F4, and a side channel straight spillway located on the left abutment. For reasons of increased stability, seepage control and economy, the box type spillway structure was selected and included as part of the proposed Tunnel Plan. The proposed spillway exposes to seepage 25 feet of structure along the shore of the reservoir compared to 125 feet for a straight side channel spillway design. This is a significant advantage in favor of the box spillway when considering the granular soils upon which the spillway must be founded. The proposed plan calls for filling the existing spillway after construction of the new spillway and outlet structure. The proposed spillway structure will contain an outlet weir with trash rack to maintain the normal reservoir level at elevation 73.4. The emergency spillway elevation of 80.90 is at the same level as that of the existing inadequate spillway.

c. Relief Tunnel. The major feature of the proposed plan is the deep rock tunnel which consists of an inlet structure combining diversion, silt retention and tunnel intake, an inlet shaft, the tunnel through rock, 4060 feet in

length, an outlet shaft and an outlet structure which disperses the tunnel flow into the Town River marsh. Design details of the inlet structure are shown on Figure F2 and the outlet structure is shown on Figure F3. The proposed tunnel cross section is shown on Figure F1. Figure 9 of the main report is a detailed plan and profile of the proposed relief tunnel. It was assumed that the tunnel will be constructed by conventional methods, that is, by drill and blast rather than by machine (mole) excavation because of its relatively short length. The tunnel will be lined with concrete. The lining was assumed to be 12 inches thick, for estimating purposes, based on one inch of thickness for each foot of finished diameter. This assumption will be verified after completion of geological investigations during final design. The average diameter of the excavated tunnel will be approximately 15 feet, providing for a reasonable rock overbreak of 6 inches, the concrete lining and a finished diameter of 12 feet. Rock bolts, mine ties and water control requirements were considered to be average for relatively sound rock conditions. In the fault zone, steel bents and liner plates will be used as temporary support. The inlet and outlet structures will be constructed of reinforced concrete incorporating all of the hydraulic control features outlined in Appendix D. The cost of the water circulation system was based on the system described in Appendix D, Chapter II, Water Quality Evaluation.

The structures will be designed to accommodate the differing foundation conditions at the surface and at the bottom of the shafts which they surmount. Tunnel grade and profile was set to provide at least two excavated diameters of sound rock above the crown of the excavation and three diameters below the overburden interface with the fault zone and allow for positive drainage of seepage water away from the working heading toward the outlet shaft. The general tunnelling characteristics of the rock formations expected to be encountered are discussed in detail in Appendix E. The nature of the in-situ soils at the shaft locations will require extensive water control measures and carefully considered earth support systems, all of which are reflected in the cost estimate.

d. Town River Improvements. The proposed improvements to Town River are required to provide for the conveyance of the tunnel discharge to Town River and thence beneath an existing parking area and Southern Artery (Rte. 3A) to Town River Bay. The amount of channel work required varies depending on the location of the tunnel outlet shaft for the different tunnel alignment options considered. The selected alignment requires that a channel be constructed from the outlet structure through the filled area on which it is located to the edge of the marsh. The channel slopes will be stabilized with an 18 inch thickness of stone protection underlain with filter stone derived from the tunnel excavation. The major feature of the Town River improvements will be the construction of a triple box conduit providing three 8-foot by 14-foot channels beneath the parking lot and Southern Artery for a total length of approximately 255 feet. The Town River Bay end of the culvert will be fitted with flap gates which will exercise the same control on inflowing tides now existing while allowing the increased outflow from the relief tunnel to exit into the bay. The location of the culvert is shown on Figure 9 of the main report and details of its construction are presented on Figure 5 of this Appendix.

2. Cost Estimates

a. General. Estimates of first costs were developed for the construction described in the foregoing paragraphs and shown on the referenced figures. The summary of estimated first costs for the selected tunnel plan is shown in Table F1. Table F2 is a detailed estimate of first construction costs for each project feature of the selected plan. Summaries of estimated project first costs for three of the tunnel options considered are presented in Table F3. Alternative tunnel alignments are shown in Appendix B. Real estate costs were taken from data presented in Appendix J.

Table F-1 Summary of Estimated First Costs(1)

Relief Tunnel	$15,718,000
Relief Tunnel Appurtenant Structures	715,000
Town River Improvements	1,363,000
Improvements at Old Quincy Reservoir Dam	574,000
Total First Construction Cost	$18,370,000 (2)
Engineering and Design	919,000 (3)
Supervision and Administration	1,286,000
Lands and Damages	175,000
Total Project First Cost	$20,750,000

(Exclusive of Interest During Construction Period)

(1)March 1980 Price level - Engr. const. cost index = 3159

(2)Includes contingencies of 15 percent for above ground construction and 20 percent for below ground construction.

(3)Excludes cost of preauthorization studies and the cost of designs currently being accomplished by local interests.

Table F-2 Estimated First Construction Cost

Item	Estimated Quantity	Unit	Unit Cost	Total Cost
Relief Tunnel				
Intake Shaft				
Through Earth	58	V.F.	$9,241	$536,000
Through Rock	136	V.F.	10,346	1,407,000
Tunnel				
Water Circulation System	1	L.S.		460,000
Excavation	4060	L.F.	1,040	4,222,400
Support	4060	L.F.	166	674,000
Concrete Lining	4060	L.F.	794	3,223,600
Water Control	4060	L.F.	32	129,900
Ventilation	4060	L.F.	32	129,900
Outlet Shaft				
Through Earth	41	V.F.	18,415	755,000
Through Rock	147	V.F.	10,620	1,561,000
Subtotal				$13,098,800
Contingencies 20 percent±				2,619,200
Total Relief Tunnel				$15,718,000

TABLE F-2 Estimated First Construction Cost (cont.)

Relief Tunnel Appurtenant Structures				
Tunnel Inlet Structure				
Site Preparation	1	L.S.		$20,000
Control of Water	1	L.S.		10,000
General Excavation	1200	C.Y.	6.00	7,200
Compacted Fill	52	C.Y.	7.00	364
Concrete	370	C.Y.	275.00	101,750
Reinforcing Steel	37,000	LBS	.42	15,540
Trash Rack & Grating	39,900	LBS	1.50	59,800
Rem & Reset Chann. Wall	1	L.S.		10,000
Waterstops	1	L.S.		3,385
Subtotal				$228,039
Tunnel Outlet Structure				
Site Preparation	1	L.S.		25,000
Control of Water	1	L.S.		75,000
General Excavation	800	C.Y.	7.00	5,600
Compacted Fill	140	C.Y.	12.00	1,680
Grating	23,950	LBS.	3.00	71,850
Concrete	560	C.Y.	275.00	154,000
Reinforcing Steel	56,000	LBS	.42	23,520
Structural Steel	15,680	LBS	1.50	23,520
Clean Up	1	L.S.		10,000
Safety Screen	1	L.S.		2,090
Subtotal				$392,260
Subtotal Inlet Struct & Outlet Struct				$620,299
Contingencies - 15 Percent ±				94,701
Total Relief Tunnel Appurtenant Structures				$715,000

TABLE F-2 Estimated First Construction Cost (cont.)

Town River Improvements				
Culvert at Southern Artery				
Site Preparation	1	L.S.		$25,000
Control of Water	1	L.S.		75,000
General Excavation	12,000	C.Y.	6.00	72,000
Sheeting	12,000	S.F.	6.00	72,000
Demolition	1	L.S.		16,000
Gravel Bedding	870	C.Y.	13.50	11,745
Compacted Fill	2500	C.Y.	4.00	10,000
Crushed Stone	1300	TON	12.00	15,600
Concrete	2831	C.Y.	175.	495,425
Reinforcing Steel	566,200	LBS	.42	237,804
Bituminous Concrete	500	S.Y.	6.50	3,250
Guard Rail	200	L.F.	15.00	3,000
Fence	200	L.F.	10.00	2,000
Traffic Control	1	L.S.	-	50,000
Clean Up	1	L.S.	0	5,000
Subtotal				$1.093,824
Channel Work				
Earth and Channel Excavation	8890	C.Y.	7.50	66,675
Water Control	1	L.S.		5,000
Filter Stone	356	C.Y.	10.00	3560
Slope Protection	1067	C.Y.	15.00	16,005
Subtotal				$91,240
Subtotal Town River Improvements				$1,185,064
Contingencies - 15 Percent +				177,936
Total Town River Improvements				$1,363,000

TABLE F-2 Estimated First Construction Cost (cont.)

Improvements at Old Quincy Reservoir Dam

Dike and Dam				
Site Preparation	1	L.S.		5,000
Water Control	1	L.S.		10,000
Excavation	2,675	C.Y.	7.00	18,725
Embankment Fill	20,000	C.Y.	6.00	120,000
Loam and Seed	22,500	S.Y.	3.00	67,500
Clearing and Grubbing	7	Ac	900.	6,300
Subtotal				$227,525
New Spillway and Outlet				
Fill Existing Spillway	167	C.Y.	7.00	1,169
Excavation	1390	C.Y.	7.00	9,730
Crushed Stone	230	Tons	12.00	2,760
Concrete	701	C.Y.	225.	157,725
Reinforcing Steel	105,150	LBS	.42	44,163
Ballast Fill	1850	C.Y.	18.00	33,300
Trash Rack	8935	LBS	1.50	13,403
Channel Excavation	200	C.Y.	7.00	1,400
Stone Protection	250	C.Y.	18.00	4,500
Fencing	382	L.F.	10.00	3,820
Subtotal				$271,970
Subtotal Imp. at Old Quincy Reservoir Dam				$499,495
Contingencies - 15 Percent +				74,505
Total Improvements at Old Quincy Reservoir Dam				$574,000
Total First Construction Cost				$18,370,000

F-3 Summary of Estimated First Cost - Tunnel Options

ITEM	TUNNEL OPTION		
	1	2	3
	4060 LF.	3520 L.F.	5660 L.F.
Relief Tunnel			
Intake Shaft	$1,943,000	$1,943,000	$1,943,570
Outlet Shaft	2,316,000	2,316,000	2,316,000
Tunnel	8,839,800	7,497,000	12,798,000
Contingencies 20 Percent ±	2,619,200	2,351,000	3,411,000
Intake Structure	228,039	228,039	228,039
Outlet Structure	392,260	392,260	392,260
Contingencies 15 Percent ±	94,701	94,701	94,701
Subtotal	$16,433,000	$14,822,000	$20,468,000
Town River Improvements			
Culvert at So. Artery	1,093,824	1,093,824	-
Channel Work	91,240	390,000	71,000
Contingencies 15 Percent ±	177,936	226,176	11,000
Subtotal	$1,363,000	$1,710,000	$82,000
Improvements at Old Quincy Reservoir Dam			
Dikes and Dam	227,525	227,525	227,525
New Spillway and Outlet	271,970	271,970	271,970
Contingencies 15 Percent ±	74,505	74,505	74,505
Subtotal	$574,000	$574,000	$574,000
Total First Construction Cost	$18,370,000	$17,106,000	$21,124,000
Engineering and Design	919,000	855,000	1,056,000
Supervision & Administration	1,286,000	1,197,000	1,479,000
Real Estate Costs	175,000	175,000	109,000
Total Project First Cost	$20,750,000	$19,333,000	$23,768,000

b. Basis for Estimates. Quantities of the principal construction items were estimated on the basis of preliminay designs which will provide safe structures for given conditions. The estimates of first costs are intended to represent March 1980 price levels when the Engineering News Record Construction Cost Index was 3080 for Boston, Massachusetts, corresponding to a twenty city national average of 3159. A contingency allowance of 15 percent of the construction costs is included for above ground construction and a 20 percent contingency applied to underground (tunnel and shaft) construction costs. Engineering and design and supervision and administration costs are estimated lump sum items based on the cost of similar projects in the area and amount to approximately 5 percent and 7 percent of the first construction costs respectively. The low percentage of engineering and design costs reflects the value of design work currently being accomplished by local interests.

c. Tunnel Costs. The COSTUN Computer Program was utilized in deriving tunnel and shaft costs for the tunnel plan. It was developed in 1973 under a contract sponsored by the U. S. Department of Transportation. The program has been extensively employed by the New England Division for the past 5 years and is used primarily in planning stages of project development.

A number of cost components were selected, the sum of which represents the basic construction cost of the tunnel-shaft system. A cost component is one of the fractional parts of the cost of a unit length of tunnel construction. Each cost component is subdivided into labor, equipment and material subcomponents to allow separate adjustments according to different cost escalation rates.

Factors affecting the magnitude of each of the cost subcomponents are also recognized. These factors include those dictated by the tunnel design (such as shape, size, lining thickness), site conditions (such as rock strength, ground water inflow), and methods of construction.

The unit cost of the subcomponents has been estimated as a function of all the factors identified as having an effect on this cost component. The resulting parametric relationships between these factors and the cost subcomponents are the data bank from which tunnel and shaft costs (per linear foot) are calculated.

These costs are adjusted for variations in unit cost according to labor, equipment and material cost indexes. Costs are further adjusted according to a regional cost factor which is dependent upon geographic influences beyond those contained in the cost indexes. Surcharges are added to each cost subcomponent to provide for contractors' overhead and profit. Subcomponent costs are multiplied by the length of tunnel to which they apply. The summation of these products for all cost components yields the basic construction cost of the proposed tunnel system.

The average unit costs for tunnel and shaft construction shown in Table F2 were derived from the output of the COSTUN program and include a contractor's overhead of 45 percent and a profit allowance of 15 percent. An

average haul distance of 1.5 miles from the outlet shaft was assumed for disposal of tunnel waste. The COSTUN program analyzes and integrates the costs of labor, equipment and materials for each reach of tunnel based on rock conditions and distance from the working shaft. The total costs per lineal foot for each reach are comprised of the costs of excavation, loading muck (waste rock), muck transportation to the heading, hoisting muck to the surface, muck disposal, rock support, forms for the lining, the concrete lining, grouting, pumping and ventilation.

d. Details of Estimates of First Costs. The following notes clarify certain details of the estimates of first costs:

1. Sheeting was estimated on the basis of a fair and reasonable price per square foot for such work. At this stage no attempt is made to determine the exact materials to be used, or how much sheeting must be left in place.

2. Cost of control of water was based on generalized knowledge of local conditions and construction. Cofferdams and bypasses were included in lump sum items for water control.

3. Lump sum prices were based on comparative cost experience.

4. Channel excavation would be used for fill, if suitable, as needed. The balance would be spoiled. It is anticipated that the Contractor wold be able to sell "good clean fill" or dump it in abandoned quarries or at other locations approved by the community.

5. The unit price for loaming and seeding is based on a nominal 6 inch depth of loam.

6. Stone protection for channel slopes was estimated to be 18 inches in thickness on a 6 inch gravel or stone filter. Material was assumed to be derived from necessary excavations.

7. The lump sum cost of the water circulation system was based on a worst case assumption to be verified or modified as a result of water quality studies to be conducted.

B. NONSTRUCTURAL PLAN

1. Summary.

In order to develop a nonstructural plan and corresponding estimated costs for flood proofing structures within the 100-year flood plain, the following procedure was followed. A field survey was performed to determine the category of all structures, estimated flood inundation, and any other information pertinent to the application of nonstructural measures. The structures were subsequently divided into two categories, residential and commercial/industrial. The commercial/industrial category also included apartments, nursing homes and other miscellaneous structures that could not be classified as residential, since the number of these within the scope of the study was minimal. The field information was used in conjunction with previously acquired field data.

Structures were grouped into four reaches according to location. A total of 154 cases were investigated, 128 of which are residential structures. These structures required one of the four types of flood proofing applicable to residential structures listed in Pargraph 2c, Nonstructural Alternatives Selected, ranging in cost from $5,000 to $20,000 per structure.

The remaining 26 structures investigated fell into the category of commercial/industrial and required one of the five types of flood proofing applicable to commercial/industrial structures listed in Paragraph 2c. Due to the range in flood inundation, the costs associated with the commercial/industrial structures ranged from below $5,000 to $130,000. The total cost for the 128 residential structures was $1,632,400; for the 26 commercial/industrial structures, $721,700.

2. Procedure.

a. Field Study.

The field study identified all structures within the 100-year flood plain. Structures were visually field evaluated for type, size, type of foundation and basement. Elevations were obtained from photo-grammetric plans with 5-foot contour intervals. Based on the above data, the depth of inundation for each structure was estimated and the appropriate nonstructural measure was applied for each case.

b. Nonstructural Measures Investigated.

Upon completion of the field investigation, the following nonstructural measures were considered and evaluated for the particular cases within the scope of the study:

1. Acquisition and demolition of structure; including relocation of homeowner, purchase of particular structure at a fair and reasonable price, demolition of that structure, and restoration of the housing site.

2. Physical relocation of a structure out of the flood plain.

3. Relocation of household mechanical and electrical equipment by:

a. Construction of a new utility room on the first floor of the house to protect the furnace, electric switchbox, gas and electric meters and hot water heater.

b. Construction of a watertight 8 foot x 8 foot concrete utility cell with watertight door in the basement to protect the furnace, electric switchbox, gas and electric meters, and hot water heater.

c. Construction of a watertight 8 foot x 8 foot concrete utility cell with access stairs (instead of watertight door) in the basement to protect the furnace and hot water heater when flood inundation is less than 3 feet. Other utilities were either assumed to be above the flood level or required to be raised to a safe elevation.

4. Raising the superstructure of a house.

5. Basement or foundation wall waterproofing.

6. Replacing fieldstone or concrete block foundations with a reinforced concrete foundation and waterproofing the foundation.

7. In areas where homes are close together, providing an architecturally treated reinforced concrete wall around a cluster of homes with access openings and closures with some means of pumping within the wall.

8. For one story homes with slab-on-grade foundations, providing a second foundation wall in front of, and abutting, the original foundation wall and footing and extending approximately 2 feet above grade. A brick veneer will be provided on the portion of the wall above grade.

9. For commercial/industrial applications where flood inundation exceeded two feet and potential damage was quite extensive, the construction of a reinforced concrete floodwall in front of, and abutting, the original wall and footing.

10. Rearranging damageable property within an existing structure; i.e. protecting property in equipment, especially electrical equipment, by permanently storing them at higher elevations on pedestals, tables, raised platforms or shelving.

11. Flood forecasting and warning.

12. Flood insurance.

Structure acquisition and demolition (Item 1) and physical relocation (Item 2) were eliminated from consideration because less severe and less costly alternatives were available to eliminate or at least substantially reduce

damages. Construction of a first floor utility room (Item 3a) was eliminated because the basement utility cell (Item 3b) provided the same level of protection. Although the cost of the basement utility cell was slightly greater, it required no additional structure area, and was preferable to the first floor utility room because in many instances additional structure area was not available. Replacing existing foundations with reinforced concrete foundations (Item 6) was eliminated because less severe and less costly alternatives were available to eliminate or at least substantially reduce damages. Rearranging damageable property within a structure (Item 10) flood forecasting and warning (Item 11) and flood insurance (Item 12) were not considered as alternatives on their own, but were considered as supplemental measures to other basic alternatives.

C. Nonstructural Alternatives Selected.

After consideration and evaluation of the nonstructural measures listed in paragraph b, the following measures were determined to be viable solutions for particular cases for either commercial/industrial structures or residential structures or both.

1. Construction of a watertight 8-foot x 8-foot reinforced concrete utility cell (with a watertight door) in the basement. (See Figure F6). The cell protects the furnace, electric switch box, gas and electric meters and hot water heater; and is applied for conditions where basement flood inundation is greater than 3 feet. This method is applied primarily in residential structures or commercial operations housed in residential type structures, and protects all utilities enclosed within the cell. Since the remainder of the basement level can still be inundated, the remaining damages associated with basement flooding are not prevented. Consideration should be given to rearranging damageable property within an existing structure (Method 5) as a supplement to this measure, especially when a sizeable amount of non-utility type damage is involved. Usually flood insurance (Method 6) should also supplement this method.

2. Construction of a watertight 8-foot x 8-foot reinforced concrete utility cell with access stairs (instead of a watertight door) in the basement (See Figure F7). The cell protects the furnace and hot water heater, and is a variation of method 1 to be applied for conditions where basement flooding inundation is less than 3 feet. This method is primarily for application in residential structures or commercial operations housed in residential type structures, but is also for application in commercial type structures with lower level flooding. Since the remainder of the basement or lower level can still be inundated, the remaining damages associated with basement flooding are not prevented. Consideration should be given to rearranging damageable property within an existing structure (Method 5) as a supplement to this method, especially when a sizeable amount of non-utility type damage is involved. Usually, flood insurance (Method 6) should supplement this method.

3. Construction of a reinforced concrete ringwall with a brick veneer exterior around a cluster of homes, with access openings and aluminum closures (see Figure F10) for each home and sump pump arrangements to drain

low-lying interior areas (approximately one sump pump set-up for every two homes). Although not usually considered as a feasible non-structural solution, this method was evaluated and is considered to be a viable alternative for the residential structures on the north and south sides of Brook Road between Payson Street and Fort Square. This was primarily due to the proximity of the homes in this area (which reduced the total length of the wall required by a sizeable amount) and the maximum height of wall required above grade (3 feet). When all aspects are functioning properly, this method will provide complete protection for all enclosed structures. However, this method is highly dependent on having sufficient time to set all closures in place and activate all sump pump arrangements (see Figure F8).

4. For one story residential structures with slab-on-grade foundations, construction of a second reinforced concrete foundation wall in front of, and abutting, the original foundation wall and footing with front and rear access openings and aluminum closures. This method was evaluated and considered to be a viable alternative for the residential structures in the area around the Old Quincy Reservoir. This was due primarily to the type of foundation (slab-on-grade), the height of the wall required (approximately 2 feet above grade), and the short duration of the inundation. This method will provide complete protection for all structures, but is highly dependent on having sufficient time to set all closures in place (see Figure F9).

5. Waterproof exterior foundation walls of structures with concrete or concrete block foundation walls with slab-on-grade foundation. Other studies have shown that for a residential type structure with concrete block foundation wall and a 4 inch reinforced concrete basement slab, the maximum depth of water that can be tolerated before the slab will fail is approximately one foot. Therefore, within the scope of this study, this method was applied only to commercial/industrial structures with concrete or conccrete block walls and slab-on-grade foundations. The concrete and concrete block are relatively impermeable and can be made more so by sealing the exterior surface. More importantly, because of the commercial or industrial nature of the building, it can be reasonably assumed that the concrete base slab was designed for a greater load than the base slab for the residential structure. Assuming this, the structure will structurally be able to withstand the maximum hydrostatic load of 2 feet encountered within the scope of this study.

In addition to sealing the exterior of the walls, temporary closures must be provided at all points of access and egress, and backflow must be prevented in sanitary sewer lines and floor drains by installing gate valves. This method will provide complete protection for all structures, but is highly dependent on having sufficient time to set all closures in place.

6. Rearranging damageable property within an existing structure by permanently storing them at higher elevations on tables, raised platforms, or shelving. This method was applied only to commercial/industrial structures as it was assumed that they would have a greater amount of damageable property, especially different types of electrical equipment, stored in lower levels. This method has been considered as both a supplement to other methods where utilities are protected but lower level flooding is still allowed and, in some

instances, on its own where flooding is allowed with no other protection. Although this method has not been formally applied to any residential structures, it should be considered where a substantial amount of damageable property is stored or exists in basements or lower levels. Usually flood insurance (Method 6) should supplement this method.

7. Construction of a new reinforced concrete floodwall approximately 3 feet high, in front of, and abutting, the existing foundation wall. This method was evaluated and considered to be a viable alternative for commercial/industrial structures when flood inundation was greater than 2 feet and the existing walls and base slab could not structurally withstand the additional load; and also when the potential damage was great enough to warrant the high cost of this method. Aluminum closure shields must be provided at all points of access and egress, and backflow must be prevented in sanitary sewer lines and floor drains by installing gate valves. This method will provide complete protection for structures, but is highly dependent on having sufficient time to set all closures in place (See figure F11).

8. Flood Insurance. This should be considered as a supplement to methods 1, 2 and 6 (since full protection is not provided) in most cases when additional nonutility type damage can occur.

9. Flood forecasting and warning. Some of the alternatives previously presented are highly dependent on the timely warning of the flood danger. In the best interests of not only protecting property but also of protecting lives of those directly affected by flooding, some type of flood warning system is imperative.

d. Flood Warning Plan.

The capability to recognize a potential flood threat early is an integral part of an effective flood warning plan. Techniques for recognizing potential flood threats vary from sophisticated forecasting models and automated gaging and communications equipment to visual inspection of streams by volunteer observers. Although the National Weather Service is responsible for preparing forecasts and issuing flood warnings throughout the United States, these forecasts are generally effective only on major streams.

Therefore, a more practical flood warning plan for the Town Brook area could be a self-contained community warning system composed of a combination of strategically placed, automatic flood alarm systems and manual observations. See graphic representation of warning system on figure F12.

The automatic flood alarm would activate an alarm or warning when the stream reaches a predetermined danger or "alert" stage. An alarm signal such as a flashing light would be located in the police or fire station. Potential locations for these alarms would be:

1. East of Fort Square behind Star Market where the brook daylights for approximately 500 feet. This location would serve as a warning for the Brook Road and the Quincy downtown areas.

2. South of Revere Road where the brook daylights after running under the downtown area. This location would serve as a warning for the Bigelow Street area.

3. Within the Old Quincy Reservoir, on the Lakeside Drive side. This location would serve as a warning for the Old Quincy Reservoir area.

These automatic flood alarms would be supplemented by the use of trained observers to monitor water levels at critical locations along the brook. These observations would begin whenever the National Weather Service forecasts such a flood potential. Specific criteria would have to be developed so that the decision to begin these observations would be timely and reasonable.

The next step is the decision to issue the warning. The timeliness and reliability of the decision to warn of an impending flood is critical to the success of the plan. The responsibility for making the decision to issue a warning must be delegated to a responsible local agency and specific criteria and guidelines must be developed, based on the available water level data and impending National Weather Service forecasts, to allow a timely decision process.

The next step is the dissemination of the flood warning in a manner that will reach the entire populace. The content of the warning would have to be sufficient to motivate the community to respond so that a minimum of flood loss occurs. The type of warning must consider the nature of the community at the time of the threat. The Town Brook area calls for a combination of radio announcements for general dissemination of information, door-to-door warning for residential areas and businesses if during regular business hours, and telephone warnings to key persons responsible for commercial entities and all other parties. The content of the warning is extremely important to motivate the community to respond effectively, while the individual issuing the warning has a bearing on the credibility. Therefore, for radio announcements, a known local official should be responsible and these announcements should be repeated to stress the urgency. For door-to-door or telephone warnings local officials such as policemen or firemen should be responsible. The content of the warning message should include a description of the appropriate course of action for the affected individuals or structures.

To summarize, automatic flood alarms would exist in three critical locations to detect any nonforecasted floods. Any forecasted events would be followed by the deployment of the manual observation system. At some point the decision to issue the flood warning would be made by a local agency, followed by the timely dissemination of the warning and appropriate actions by affected parties.

The total first cost to set up this warning plan would be approximately $25,000. There would also be annual costs of approximately $15,000 - $25,000 including equipment maintenance and manpower costs.

e. Operations and Maintenance

All systems and implements of the nonstructural plan must be kept in a perfect state of readiness and be easily accessible at all times. Therefore, periodic inspection, testing, and continued maintenance is of the utmost importance to the satisfactory performance of the system. Assuming an annual operations and maintenance cost of 2-1/2 percent of the total cost, the annual operations and maintenance cost for residential structures is approximately $40,000.00 and for commercial/industrial structures, approximately $25,000.00.

3. Presentation of Results.

Table F-4 presents a breakdown of the results for each reach. The number of cases for both residential and commercial/industrial categories are listed for each reach along with the corresponding costs.

Table F4

SUMMARY NONSTRUCTURAL PLAN

		COMMERCIAL/INDUSTRIAL		RESIDENTIAL	
REACH	AREA	NO.	COST $1000's	NO.	COST $1000's
1	Brook Road	10	307.9	69	957.4
2	Bigelow Street	5	191.1	25	222.5
3	Braintree	-	-	34	452.5
4	Quincy Downtown Shopping Center	11	472.2	-	-
	TOTALS	26	971.2	128	1,632.4

Table 5
COST ESTIMATES

1. 8x8 Utility Cell with Watertight Door

Concrete	8 c.y. @ $300/c.y.	2,400	
Waterstops		200	
Watertight Door		5,000	
Electrical Work		300	
Relocate Heating Equipment		1500	(average)
Check Valve		700	
		10,000	
	20% Contingency	2,020	
		12,120	say 12,200

2. 8x8 Utility Cell with Access Stairs

Concrete	4 c.y. @ 300/c.y.	1,200	
Waterstops		200	
Electrical Work		300	
Relocate Heating Equipment		1,500	(average)
Check Valve		700	
		3,900	
	20% Contingency	780	
		4,680	say 4,700

3. Reinforced Concrete Ringwall

Materials/Linear Ft.		
Brick 3 S.F./L.F. @ $6/L.F.	18.00	
Concrete 0.35 C.Y./L.F. @ $270/C.Y.	94.50	
Excavation 0.2 C.Y./L.F. @ $15/C.Y.	3.00	
	115.50	say $116 L.F.

Aluminum Closure Shields

Small $(3.25)^2$(1/4" thick)(144)(.098 #/in^3) = 37.3 say 50# (including
Large (12)(1/4" thick)(144)(.098 #/in^3) = 137.5 say 155# brackets and fixtures)

Installation - 1 mason & helper 6 hours/small shield @ 300/day 225
1 mason & helper 8 hours/large shield @ 300/day 300

Small Shield			
Material (Aluminum - 6061-T6)	50# @ $3.00/LB		150
Labor			225
			375
		20% Contingency	75
			$450

Large Shield

Material (Aluminum - 6061-T6)	155# @ $3.00/LB	465
Labor		300
		765
	20% Contingency	153
		918
	say	925

North Side of Brook Road (16 houses)

Concrete wall 1650 L.F. @ $116/L.F.	$191,400	
16 large shields @ $925	14,800	
16 small shields @ $450	7,200	
8 sump pump set ups A $1,000	8,000	
(assume 1 set-up per 2 houses)	221,400	
20% Contingency	44,280	
	$265,680	say $265,700

South Side of Brook Road (17 houses)

Concrete wall 1750 L.F. @ $116/L.F.	203,000	
17 large shields @ $925	15,725	
17 small shields @ $450	7,650	
9 sump pump set ups @ $1,000	9,000	
	235,375	
20% Contingency	47,075	
	282,450	say $282,500

4. Second Foundation Wall (Houses with slab-on-grade foundation)

Assume 142 L.F. to be perimeter of average house and determine cost per linear foot.

Concrete 24 C.Y. @ 270/C.Y.	6,480	
Brick 213 S.F. @ 6/S.F.	1,278	
Excavate & Backfill	500	(avg)
Remove & Replace Stairs, etc.	500	(avg)
Remove & Replace Shrubs, etc.	750	
2 small shields @ 450	900	
	10,408	
20% Contingency	2,082	
	12,490	

12,490/142 - 87.95
say 88/L.F.

Therefore, cost per structure = Perimeter (L.F.) x $88/L.F. + $1,000 (for large shield, if house has garage)

5. Three-foot high R.C. wall @ commercial structures

Material/L.F.

Concrete .34 C.Y./L.F. @ 270/C.Y.	91.80
Exc. & Backfill .4 C.Y./L.F. @ 15/C.Y.	6.00
	97.80 say $98/C.Y.

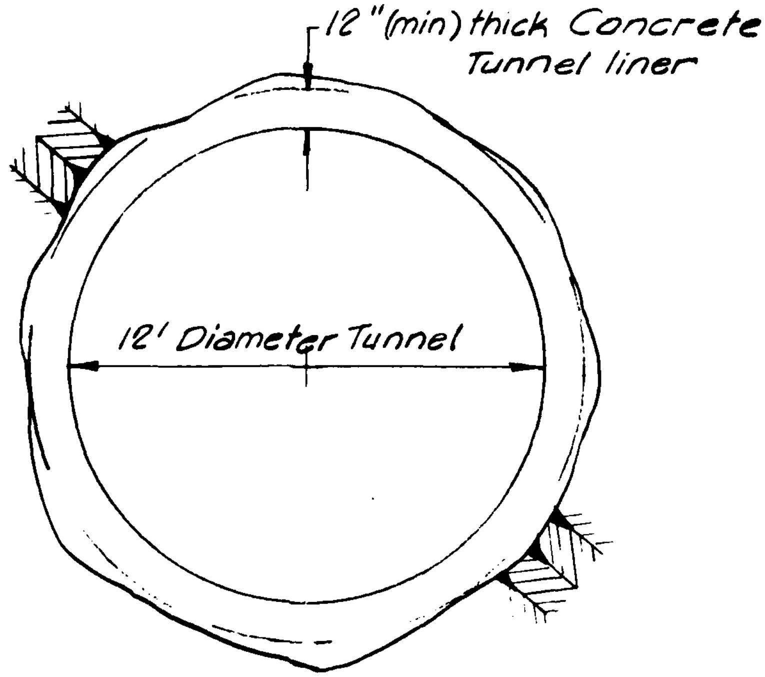
6. Flood Warning Plan

First Costs

3 flood alarm units @ 5,000	15,000
Additional phones & set up at police or fire station	10,000
	25,000

Annual Costs

Maintenance of Equipment	5,000
Manpower	10,000-20,000
	15,000-25,000



TUNNEL SECTION

Scale: 1" = 4'

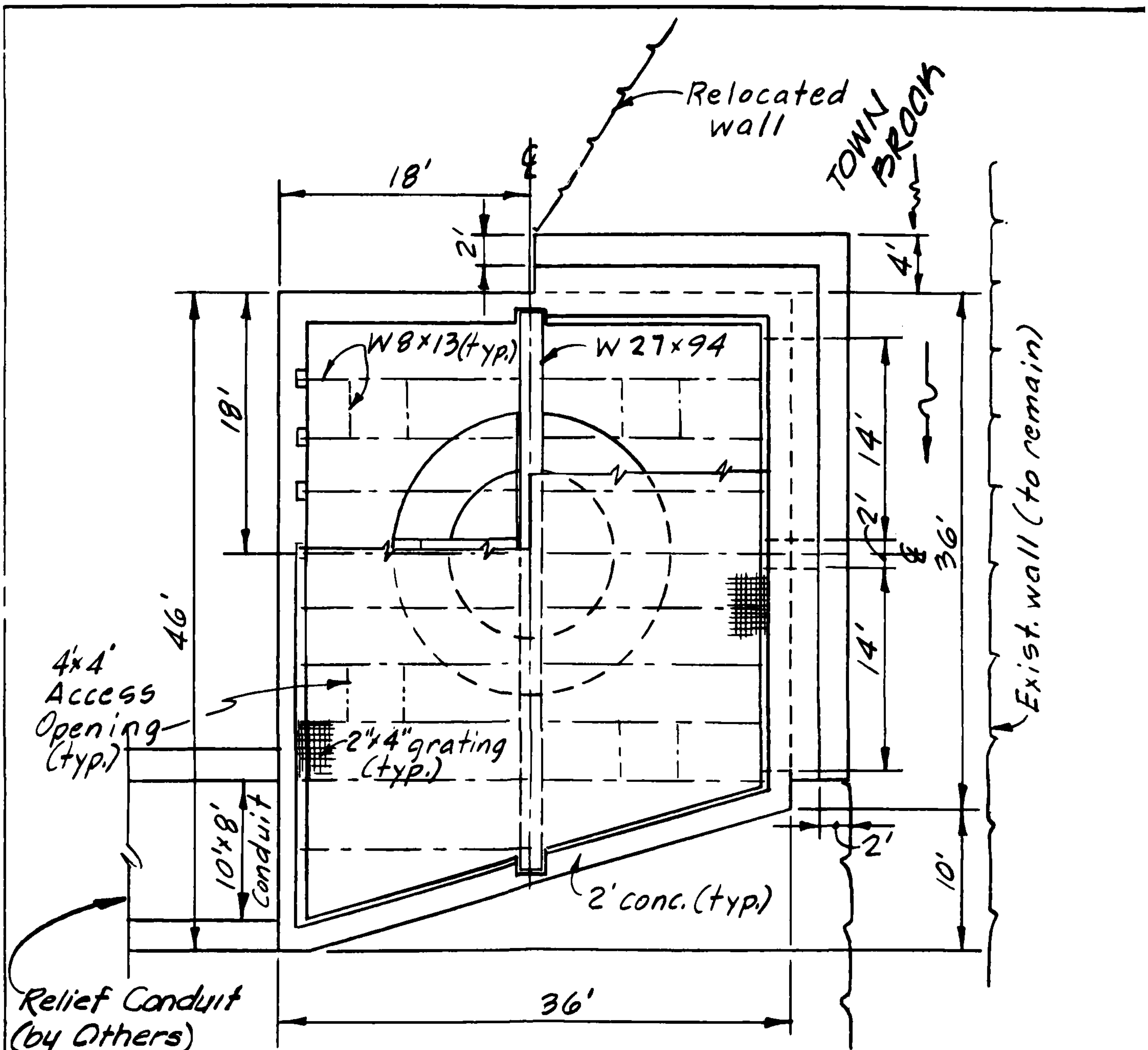
Principal Quantities.
Excavation - 7.0 cy/l.f.
Concrete Lining - 2.36 cy/l.f.

TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

TYPICAL TUNNEL SECTION

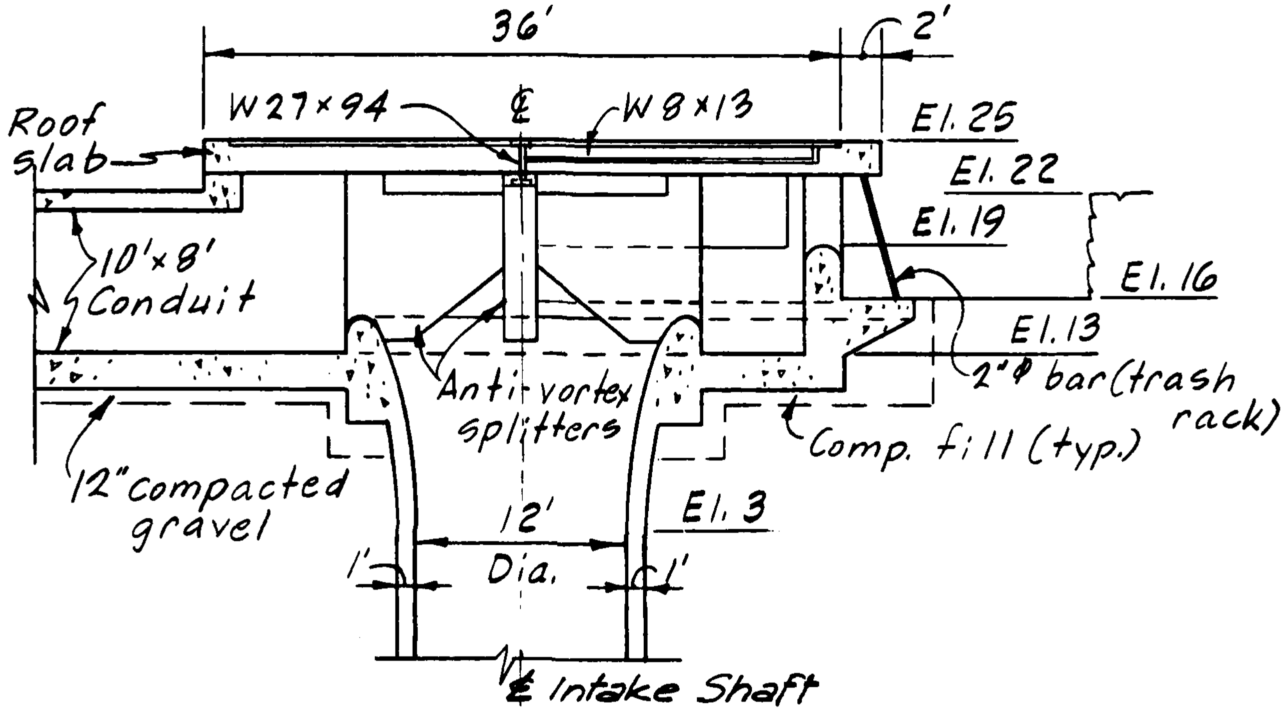
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

Figure F-1



PLAN

SCALE: 1" = 10'



SECTION

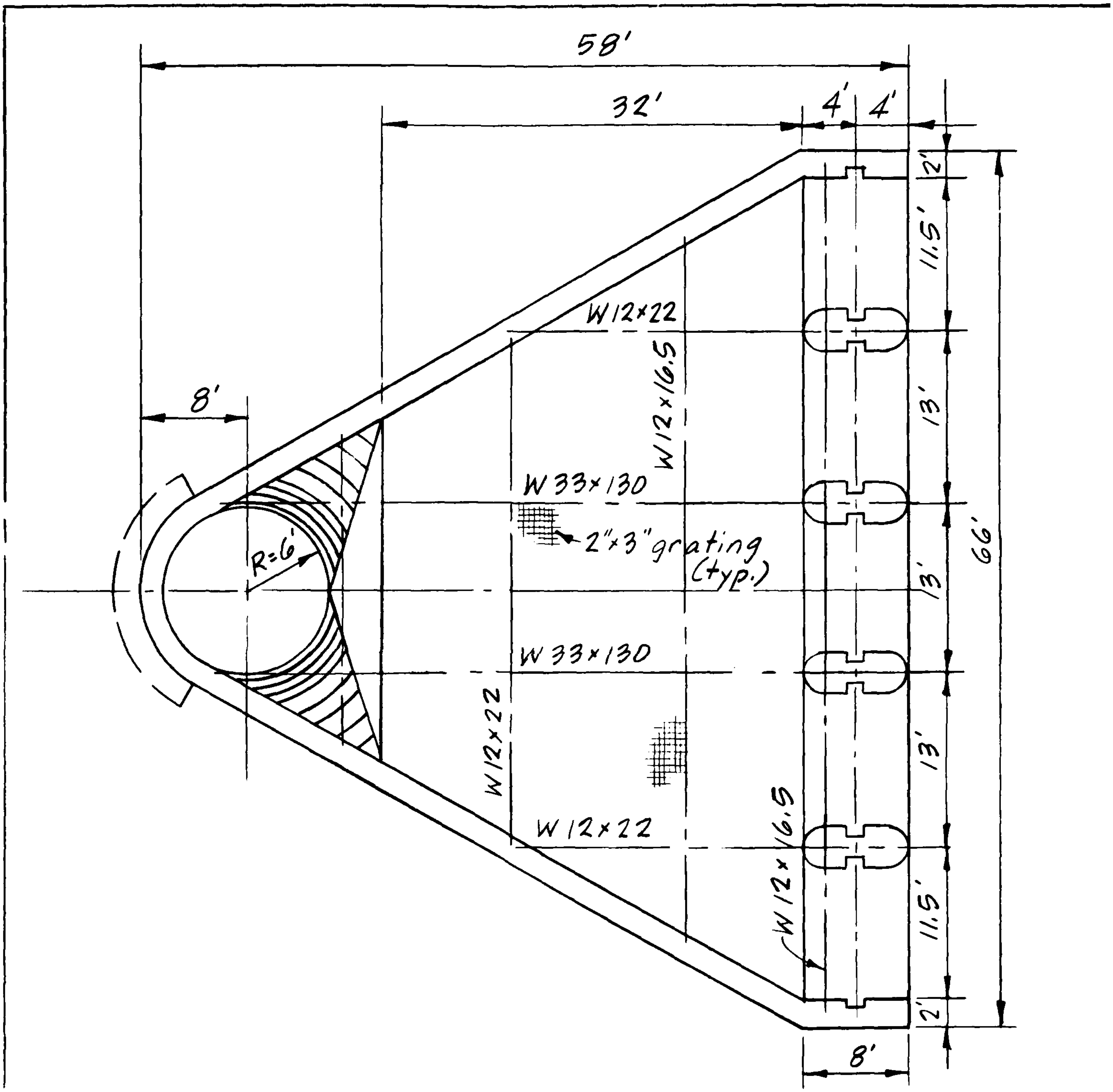
SCALE: 1" = 10'

TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

INLET STRUCTURE

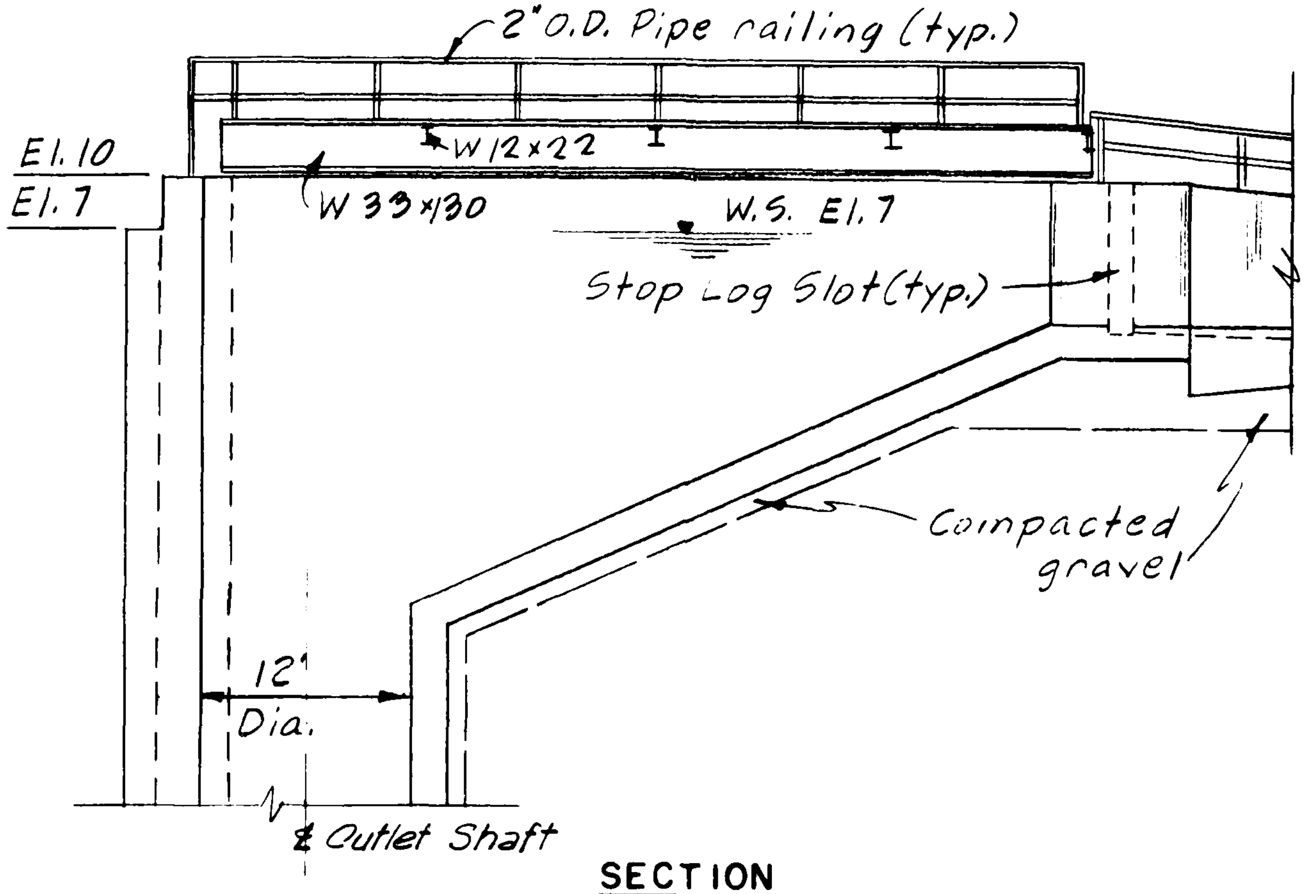
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

Fig. F-2



PLAN

scale 1":10'



SECTION

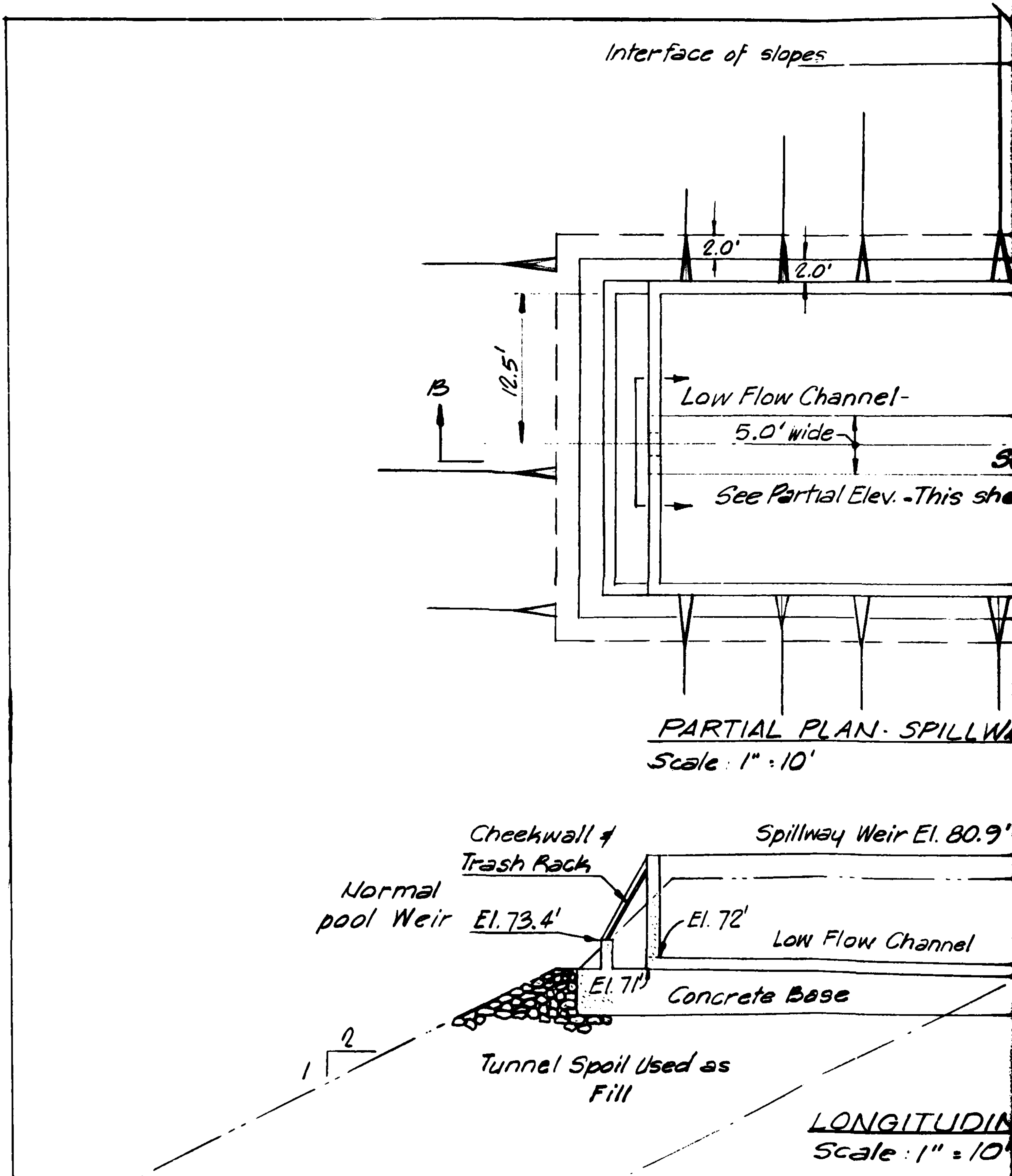
SCALE 1" = 10'

TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

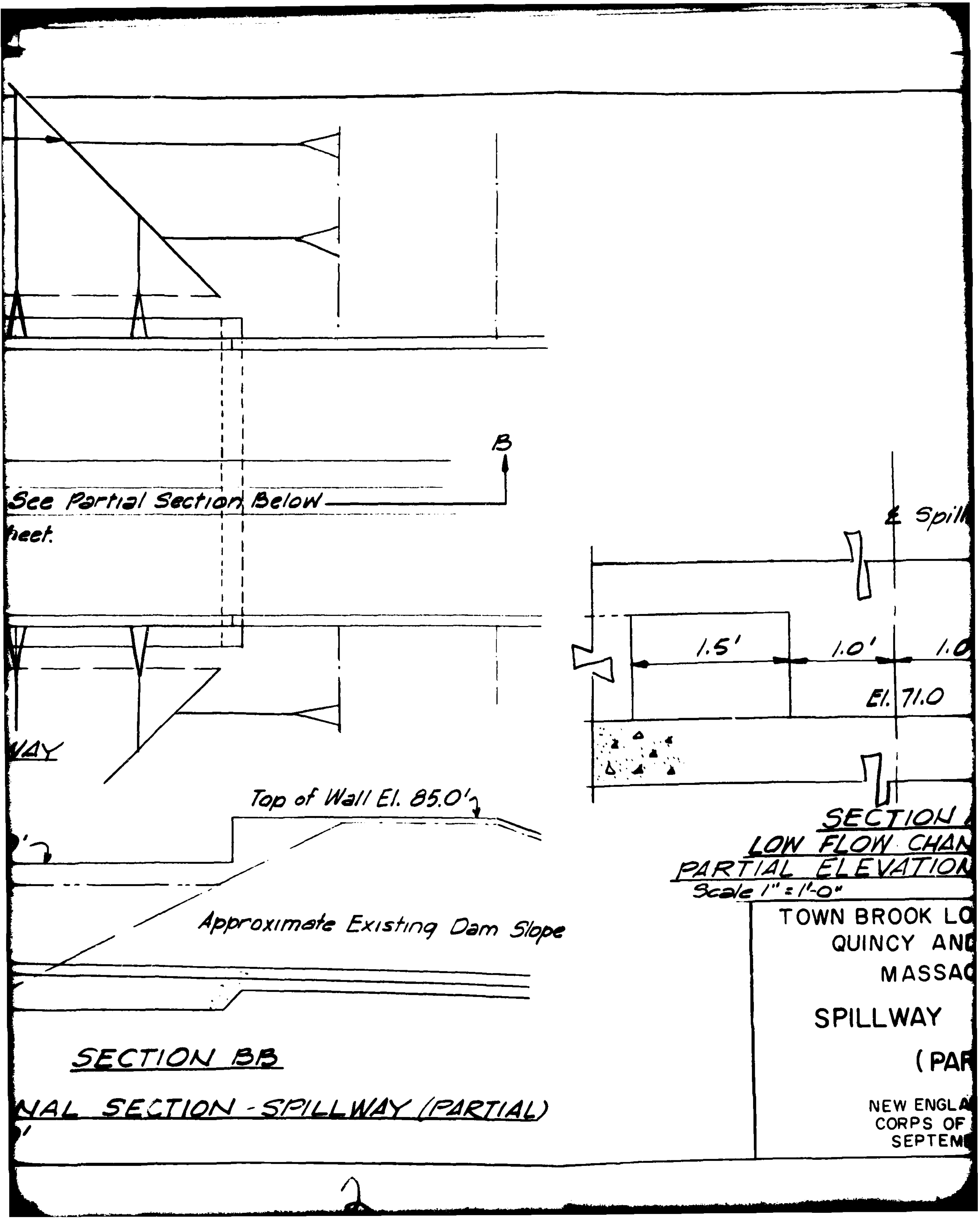
OUTLET STRUCTURE

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

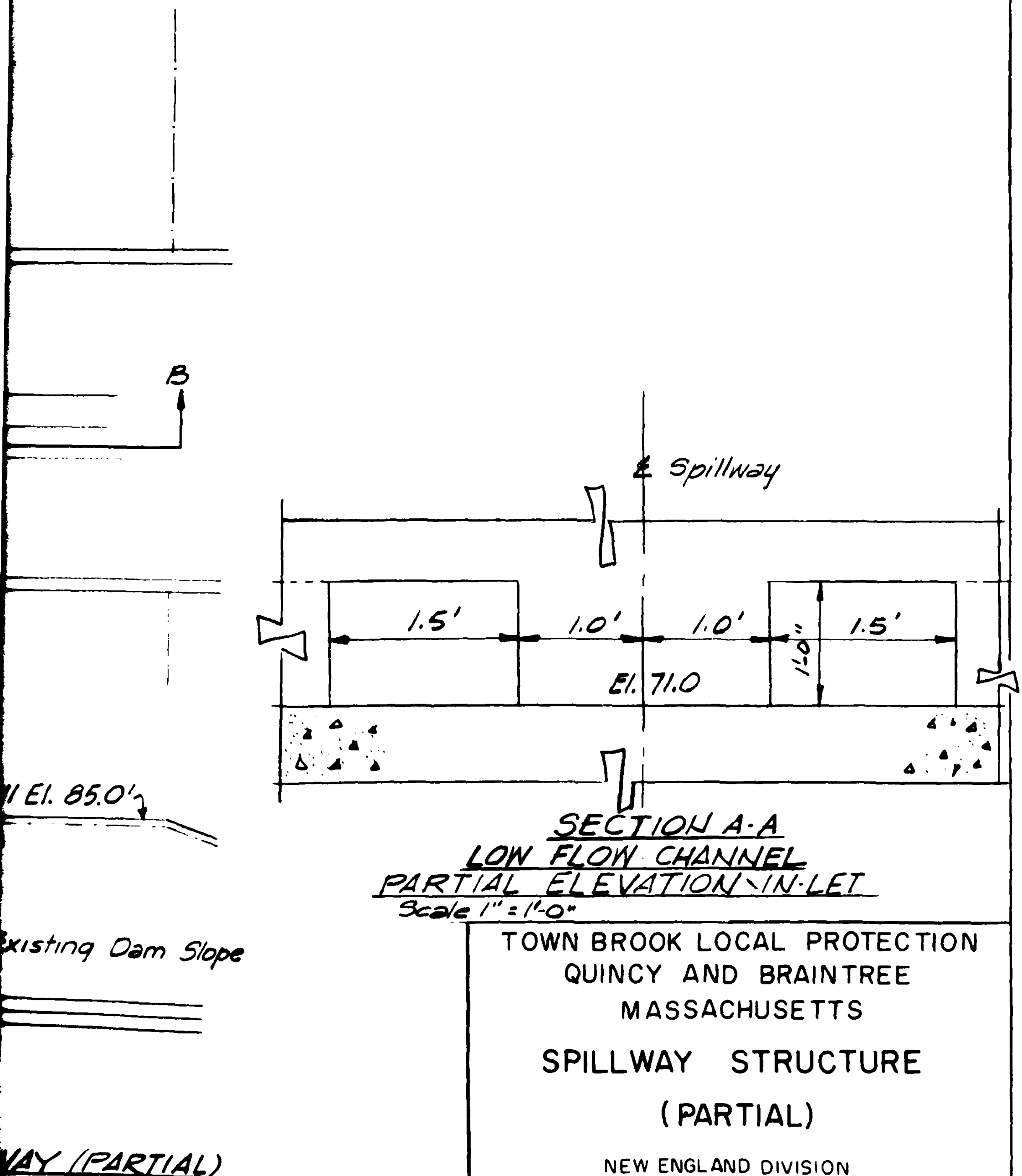
Fig. F-3



Interface of slopes
2.0'
2.0'
12.5'
B
Low Flow Channel-
5.0' wide-
See Partial Elev. -This sh
PARTIAL PLAN · SPILLW
Scale : 1" : 10'
Cheekwall &
Trash Rack
Spillway Weir El. 80.9'
Normal
pool Weir
El. 73.4'
El. 72'
Low Flow Channel
El. 71'
Concrete Base
2
1
Tunnel Spoil Used as
Fill
LONGITUDIN
Scale : 1" = 10'



B
See Partial Section Below
heet.
℄ Spill
1.5'
1.0'
1.0
El. 71.0
WAY
Top of Wall El. 85.0'
Approximate Existing Dam Slope
SECTION
LOW FLOW CHAN
PARTIAL ELEVATION
Scale 1" = 1'-0"
TOWN BROOK LO
QUINCY AND
MASSAC
SPILLWAY
(PAR
NEW ENGLA
CORPS OF
SEPTEM
SECTION BB
NAL SECTION - SPILLWAY (PARTIAL)

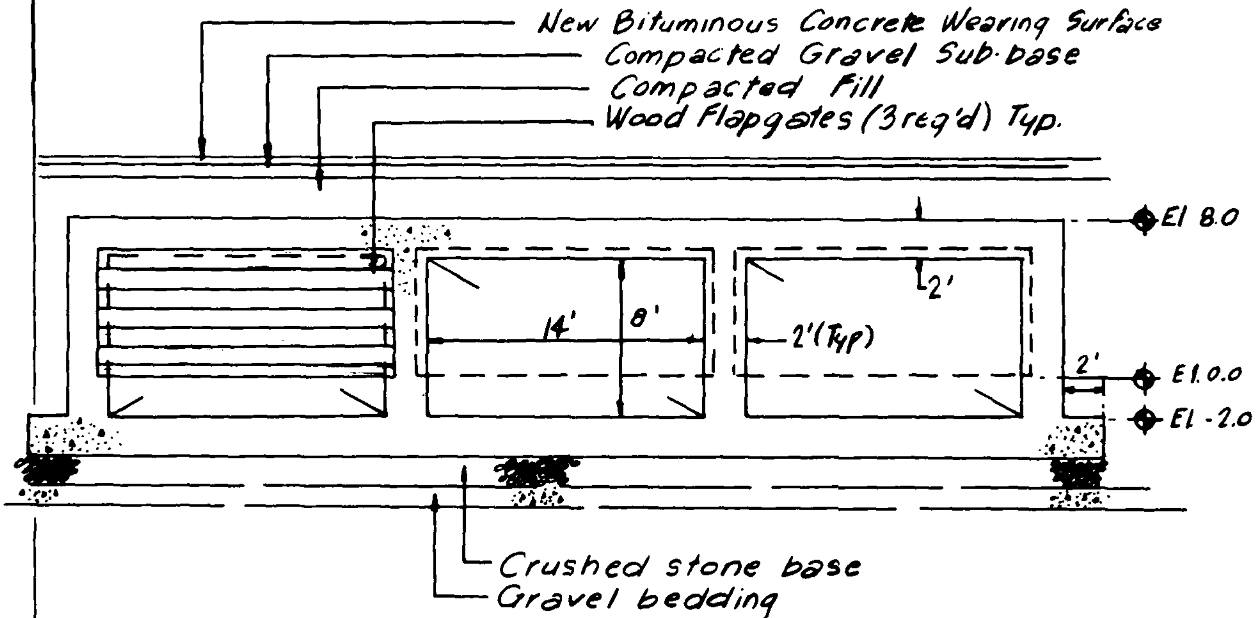


TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

SPILLWAY STRUCTURE
(PARTIAL)

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

Fig F-4



DOWN-STREAM ELEVATION

Scale : 1" = 8'

Note: Southern Artery Culvert is approximately 255 l.f. in length at a skew ∡ of 26° ±

TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

SOUTHERN ARTERY CULVERT

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

Fig F-5

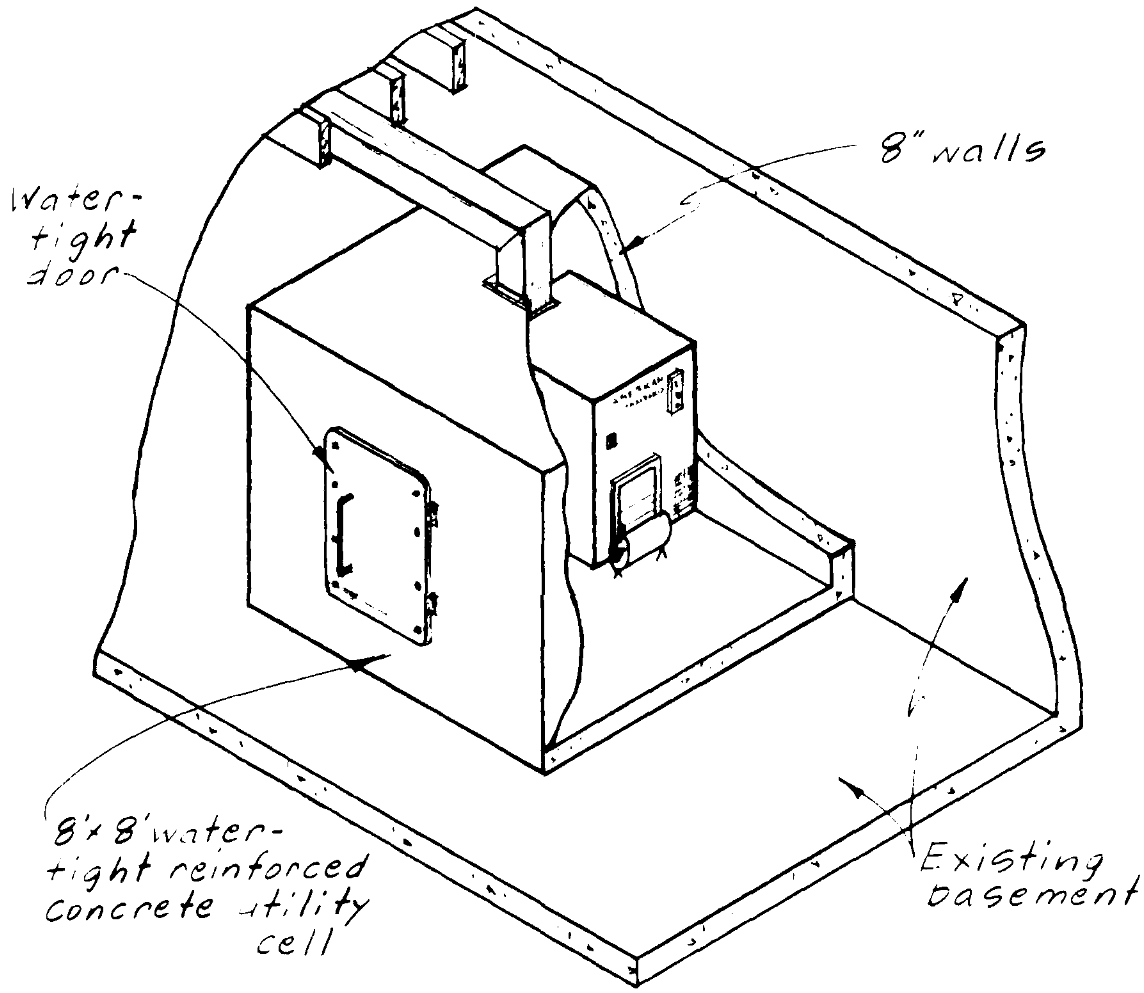


FIG. F6 UTILITY CELL WITH WATERTIGHT DOOR

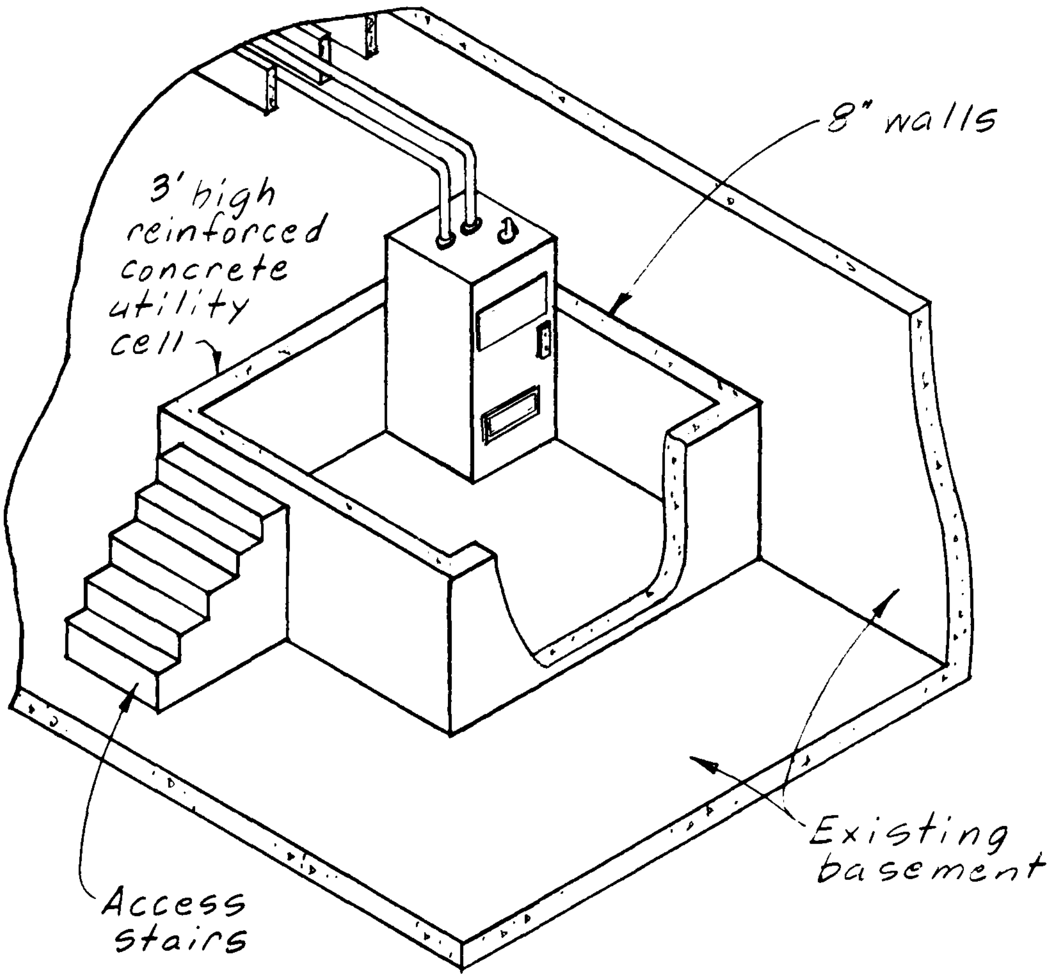


FIG. F7 UTILITY CELL WITH STAIRS

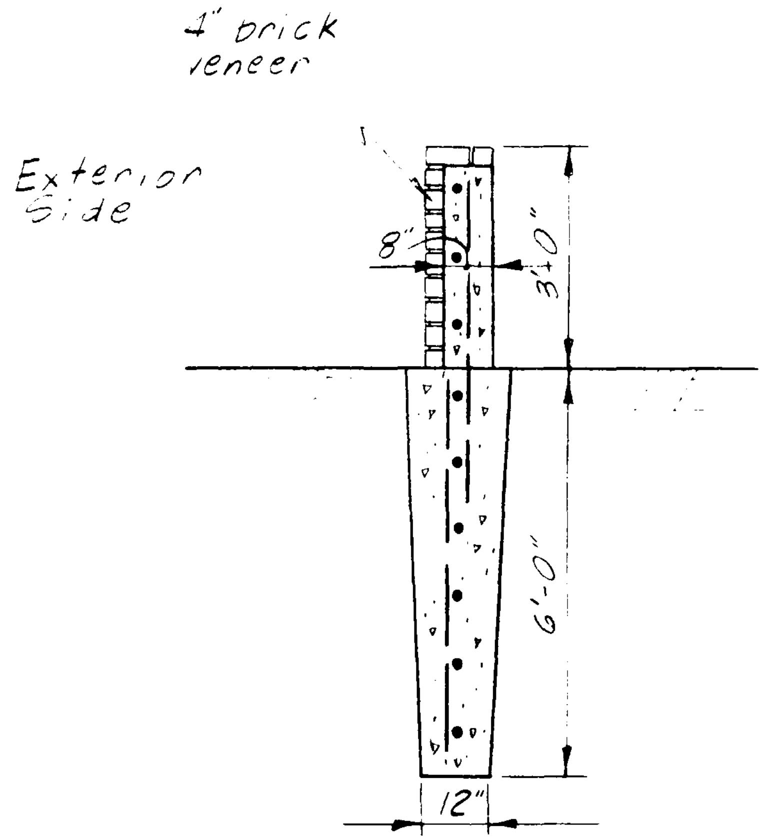


FIG. F8 TYPICAL RING WALL SECTION

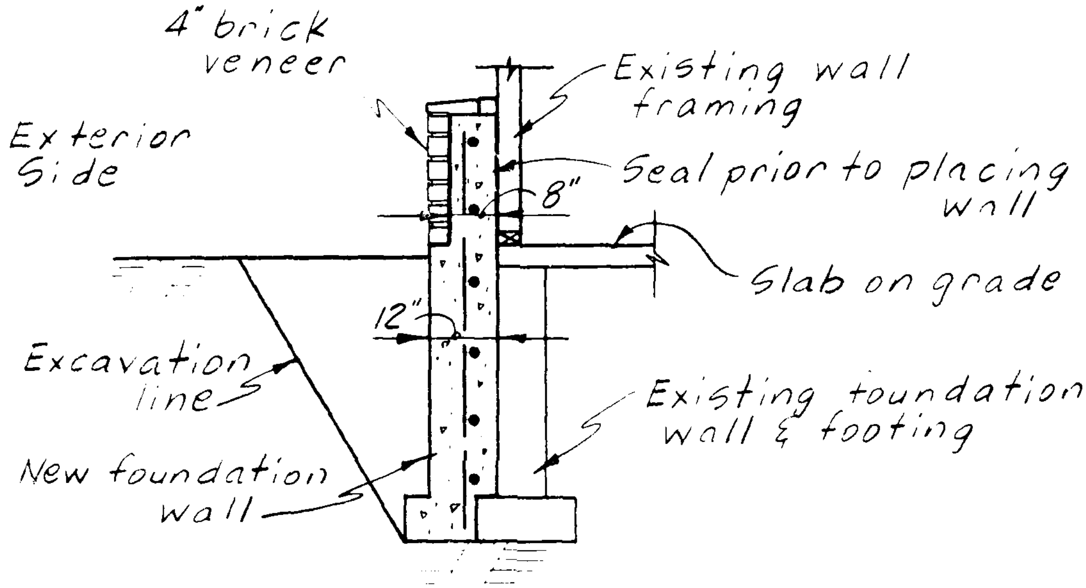


FIG. F9 NEW FOUNDATION WALL AT RESIDENTIAL STRUCTURES WITH SLAB-ON-GRADE FOUNDATION

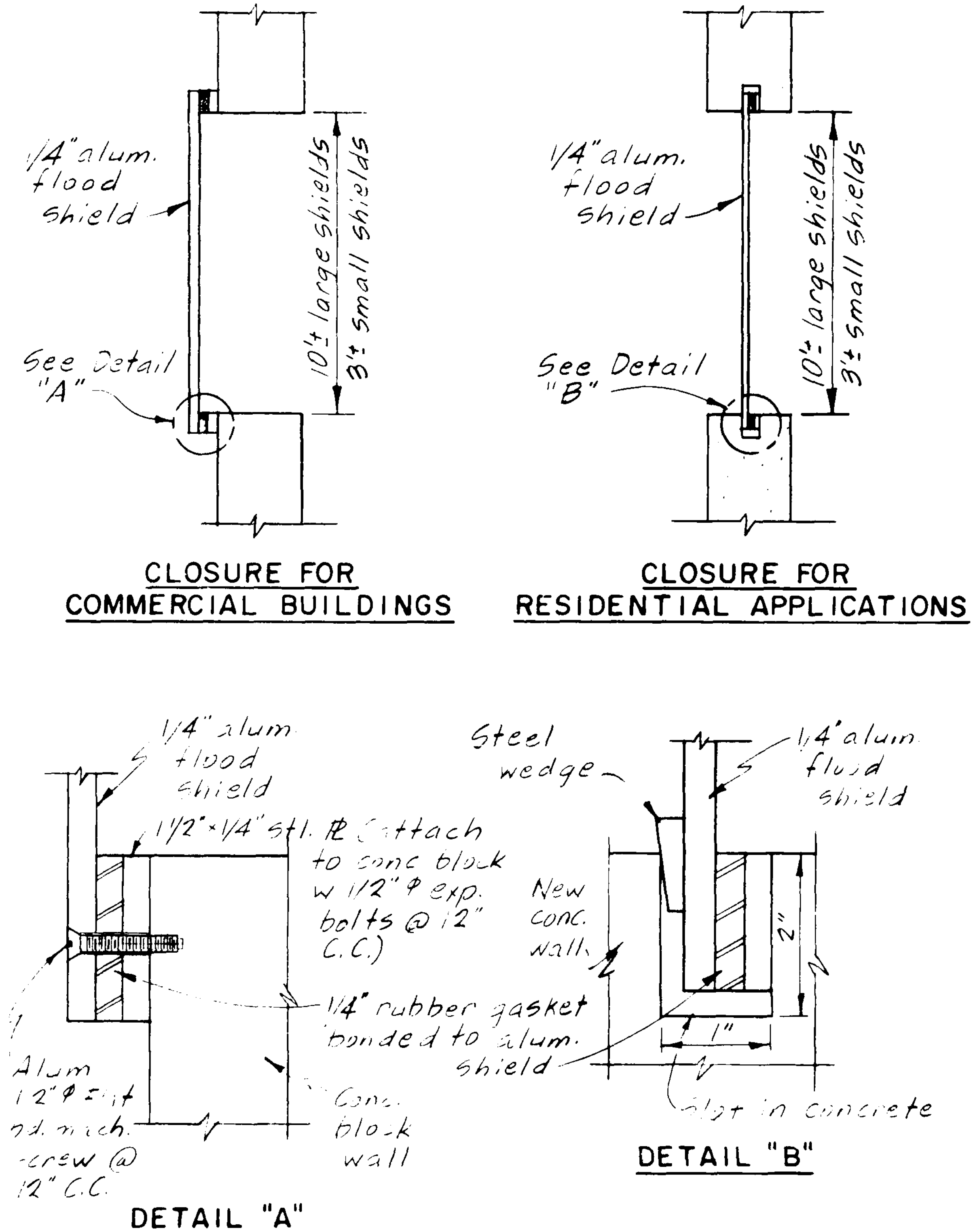


FIG. F10 ALUMINUM CLOSURE DETAILS

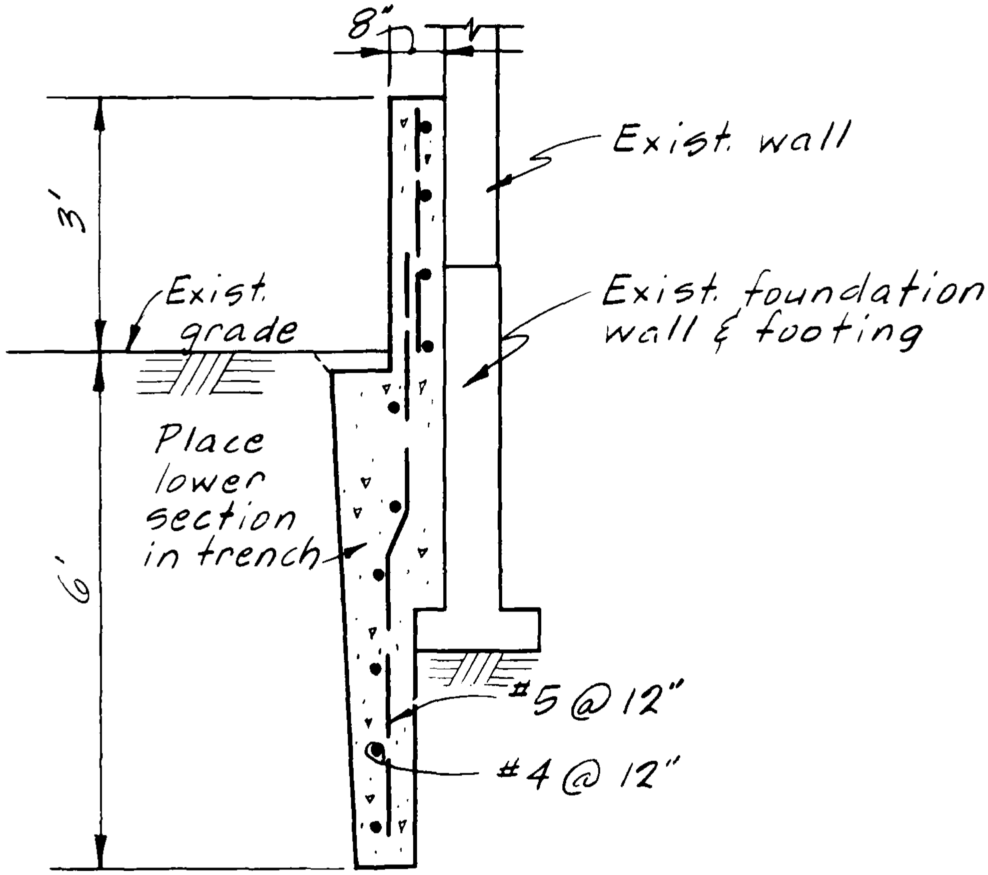


FIG. F11 3 FT. REINF. CONC. WALL AT COMMERCIAL STRUCTURES

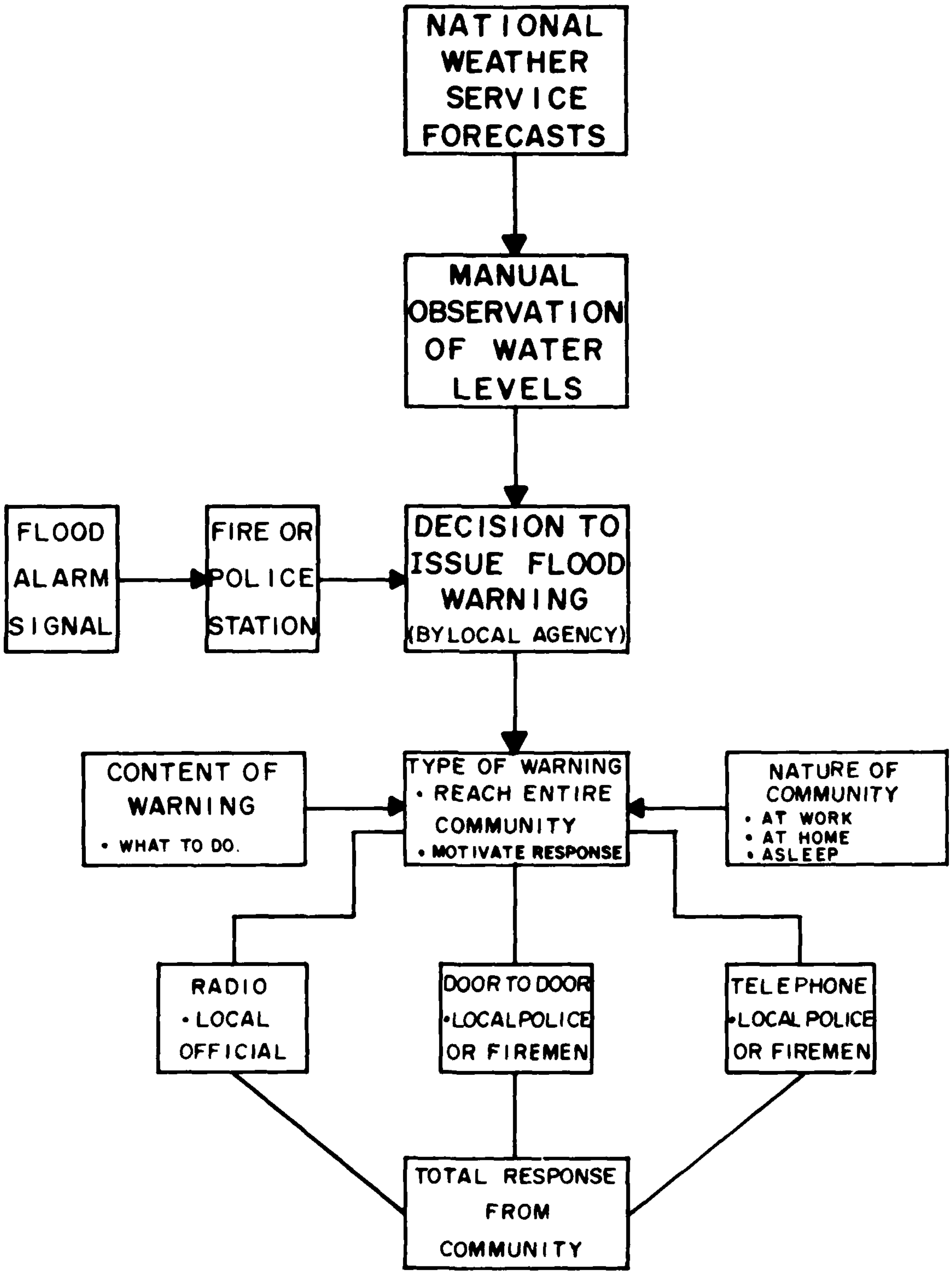


FIG. F12 FLOOD WARNING PLAN–WARNING DISSEMINATION PROCESS

Appendix G

Recreation and Natural Resources

APPENDIX G
NATURAL RESOURCES

	Page No.
ENVIRONMENTAL SETTING	C-1
Old Quincy Reservoir	G-2
Freshwater Wetland	G-2
Smelt Resource	G-2
Town River Coastal Wetland	G-4
Other Natural Resources	G-5
EFFECTS ASSESSMENT ON NATURAL RESOURCES	G-5
Blue Hills Reservation	G-6
Old Quincy Reservoir	G-6
Old Quincy Reservoir to Tunnel Inlet Structure	G-7
Downtown Quincy to Revere Road	G-8
Revere Road to Elm Street	G-8
Elm Street to Town River Bay	G-8

APPENDIX G - NATURAL RESOURCES

A. Environmental Setting

The natural resources of the study area are predominantly influenced by the urban and highly developed suburban and commercial areas around Quincy. Since the ecological features there are limited, the principal concern for natural resources is to protect the town's few remaining open spaces and natural areas. Those areas and concerns related to the flooding problems and any relief project are (beginning with upstream features): (1) the Old Quincy Reservoir; (2) the upstream freshwater wetland between Route 3 and Centre Street; (3) the smelt fishery and its spawning area between Revere Road and McGrath Highway at Elm Street; and (4) the Town River coastal wetland and smelt migration route between Elm Street and Town Brook River Bay.

Town Brook originates in the heavily wooded Blue Hills Reservation and flows into the Old Quincy Reservoir. The reservoir discharges through a regulating pipe at the base of the dam, where the brook continues to flow in an open natural channel through a wooded area and then along residential yards towards State Route 3. Between Route 3 and Centre Street the brook enters a freshwater wetland but remains within its channel except during excessive flows. From the wetland the brook flows under Centre Street, where it again surfaces for approximately 200 feet in an open channel overgrown with vegetation. The brook then enters an underground conduit system where it is conveyed through most of the remainder of the watershed. It surfaces briefly for a few hundred feet in a stone walled channel upstream of the new Massachusetts Bay Transit Authority tracks at the upstream end of the central business district. The brook reenters a conduit to pass under the central business area where it again resurfaces at Revere Road downstream of several retail stores and parking lots. For the next several blocks, between Revere Road and the lower Bigelow Street crossing, it flows in a vertical stone walled channel alongside residential properties. After entering a conduit for the stretch between Bigelow and Washington Streets the brook again flows through a stone channel until Elm Street, after which, it passes into a tidal wetland.

One of the important ecological areas of the watershed is from Revere Road to the tidal influence. This section of stream is a smelt spawning ground. From Elm Street to the Southern Artery the brook widens to Town River, which cuts through a tidal salt marsh in a natural open channel. This wetland represents another important natural resource feature.

After the Southern Artery, Town River opens into Town River Bay. There is very little water quality information for Town Brook. A summary of the available information is presented in Appendix D. Generally, the water quality standard for class B is Town Brook and class SB in the coastal tidal section of the brook called Town River. Although the brook does not receive domestic wastes, its water quality is substantially influenced by urban runoff and drainage.

Old Quincy Reservoir

The reservoir is nearly 45 acres in size and holds approximately 180 million gallons of water. Although the reservoir is located in Braintree, Massachusetts, it is actually owned by the city of Quincy, which purchased the property to create a reservoir and water supply for Quincy. After the city connected to the regional water system only the General Dynamics Corporation used the reservoir for supply. Until 30 years ago the reservoir was used for swimming and fishing, since then recreational use has been discouraged.

The reservoir is not suitable as a habitat to sustain a productive fishery. The reservoir has a barren shoreline with little vegetative growth, due in part of the constantly fluctuating reservoir, the shallow top soil layer, and perhaps the acidic nature of the water. In 1966 a fishery survey found yellow perch, bullhead, and pickerel. Although the pond had been previously stocked with trout none were found. Because only a few species were found it appeared that the reservoir could not support a significant fishery. As a result of the survey a chemical analysis of the water was made to further evaluate the reservoir's habitat potential. The results showed that the reservoir and downstream waters were too acidic (below pH5) to support trout. The few species present at the time of the survey had probably adapted and evolved a tolerance for the high acidity and apparent lack of primary production growth. Developing and managing a fishery with additional stocks or species could not be done without substantial expenditure for new stock, pH balance and fertilizer.

Freshwater Wetland

Between Route 3 and Centre Street, Town Brook bisects a freshwater wetland which covers 8 to 10 acres of a 60-acre wooded site. This wetland provides habitat for terrestrial fauna and supports vegetation not abundant in other areas of the Town Brook watershed. This wetland has a diverse vegetative cover ranging from wetland grasses in saturated soils to hardwood trees in areas occasionally flooded and poorly drained. The U.S. Fish and Wildlife Service felt that it "is not a highly significant wildlife area," but would serve to provide a small habitat area or resting site for small ground mammals and ducks. Although no survey was conducted, the area should support such vegetative cover as scrub oak, white oak, various ferns, high and low bush blueberry, red maple, dogwood, arrowwood, jewelweed, hazelnut, and several types of grasses and mosses.

Smelt Resource

After flowing through a conduit beneath Quincy's central business area Town Brook surfaces in the open stone walled channel downstream of Revere Road. From this point to the Bigelow Street crossing 1,500 feet downstream the brook provides a very favorable spawning area for rainbow smelt (*Osmerus mordax*). The substrate has a fairly uniform sandy consistency with some gravel and stream grasses. Fine materials are carried off downstream except on the low energy side of the stream bends. Even these areas are subjected to periodic surges caused by heavy storm runoff. The substrate is suitable for

smelt spawning and it appears the water quality is generally satisfactory for spawning and egg development. Adverse runoff conditions have, on occasion, resulted in heavy mortality of spawning smelt.

Above Revere Road spawning is severely limited because of the adverse conditions experienced in the underground conduits. In addition, a low level obstruction just downstream of Revere Road creates a "jump" too high for most smelt to get past since they cannot traverse obstacles greater than 3 to 4 inches high. While some of the stronger females can traverse the obstruction, they are left upstream in the conduits without accompanying males.

Smelt spend most of their life in saltwater, ascending freshwater streams in the spring to spawn. The fish prefer flowing water as opposed to ponds or tidal estuaries for spawning. The smelt spawn at night when water temperature rises to about 50 degrees F. In Town Brook this normally takes place in April and is usually completed by the middle of May.

Spawning in Town Brook is, for the most part, confined between Revere Road at the upper limit and the tidal influence near Elm Street at the downstream end. Spawning above tidal influx is necessary since saltwater can kill the eggs and, on occasion, tidal flooding during spawning could inhibit egg development. The eggs sink to the bottom of the stream where they stick, often in clusters, to nearly everything including pebbles, sticks, roots or blades of grass. The incubation period for the eggs is approximately 13 days. After spawning the adult smelt return to Town River Bay.

In the Quincy-Weymouth area smelt spawn in the Broad Cove, Weymouth-Fore, Weymouth Back, Weir and Town Rivers and other smaller streams. The Weir and the Weymouth-Fore Rivers support the largest smelt runs in Massachusetts. Town River has a significant smelt run, although it is substantially less important than the Weir River run. No counts are available, but the streams' limited spawning area becomes over- crowded with spawning smelt. A heavy spawn will actually result in the stream bottom becoming so covered with eggs that some smothering occurs.

The number of smelt in the Boston area have decreased significantly in the last 50 years as a result of pollution, conduits, or streams being closed or obstructed. However, it is possible to reestablish smelt by stocking with eggs or fry. Severe mortalities of a year class will not usually result in the elimination of smelt from any one spawning area. Healthy adults will return to the same stream for 2 to 3 years to spawn, and this helps to maintain a sufficient stock. Immature fish may not attempt to spawn in their first season thus maintaining a stock in open salt water not subject to any catastrophic events occuring in the stream. They would then be available for spawning the next season.

Town Brook maintains only a single species of fish. It does not support any natural or stocked populations of in-stream fish. Alewives (Alosa pseudoharengus) require small ponds, which do not exist on Town Brook, and they will not pass through long cuvlerts such as those along the brook. As a result, Town Brook is not suitable for spawning alewives.

Town River Coastal Wetland

This wetland is only a remnant of the coastal wetlands that had covered the area. There remains an area of approximately 4 to 5 acres which is bisected by Town River. The river at this point averages 20 to 25 feet in width and is approximately 2,000 feet long. At low tide, the water in the channel is 1 - 1.5 feet deep and consists entirely of brook flow. On either side of the channel is an intertidal wetland that is saturated by the inflowing tide. The width of the intertidal area varies from up to 75 feet on either side of the channel in the mid/downstream sections of the marsh to just a few feet on each side in the upper portion near Elm Street.

The channel has gentle meanders in the downstream half of the marsh, and is relatively straight in the upper portion. The channel bottom is sandy with a few small stones and very little silt or organic matter deposited on the sand. The floor is approximately 3 to 4 feet below the rest of the marsh, and in places the channel has undercut the bank.

The salinity in Town River varies greatly in response to the tide and the volume of freshwater runoff. The salinity of the river below Elm Street is generally between 5 ppt (parts per thousand) and 32 ppt.

The marsh adjacent to the channel supports a relatively dense growth of saltwater cordgrass (Spartina alterniflora). In some portions of the marsh, salt meadow grass (Spartina patens) grows on the landward side of the cord grass, and reeds (Phragmites communis) inhabit the area above the meadow grass. The area of the marsh that supports the cord and meadow grasses consists of a layer of deposited organic material approximately 4 feet thick. Other types of marsh vegetation include Distichlis sp., Limmonium sp., Iva frutescens and seaside goldenrod.

The main channel and the several small internal channels entering the river in the marsh support a diverse and abundant community of estuarine animals. Fish observed in the marsh include three spine sticklebacks (Gasterosteus aculeatus), killifish (Fundulus spp.), smelt (Osmerus mordax), eels (Anguilla rostrata), and larvae and juveniles of several species. Invertebrate animals inhabiting the marsh include scuds (Amphipoda), ribbed mussels (Modiolus demissus), small crabs (Portunus spinimanus) and worms (Polychaeta). The marsh also provides a variety of habitat for a small number of birds and mammals in the otherwise heavily developed city of Quincy.

The marsh functions as a major link in the food web of the river by supporting vegetation (primarily the grasses) that converts nutrients, carbon dioxide, and sunlight into usable organic matter. The organic matter is used as a food source by many invertebrates which, in turn, are fed on by fish. Gradual decay of the vegetation in the salt marsh releases not only organic matter usable as a food source but also nutrients that become available for plant growth. This is a major reason for the diversity and abundance of estuarine animals inhabiting the marsh. Many species inhabit the marsh throughout their entire life cycle while others utilize the marsh's resources as a nursery area to grow and mature in a protected environment with an abundance of food.

The resources of the marsh are not confined to Town River. Much of the organic matter and other sources of food produced in the marsh are also important to the Town River Bay system. The acreage of saltwater wetlands associated with Town River, Town River Bay, and the Weymouth- Fore River was measured from vegetative cover maps. According to the measurement, there are approximately 228 acres of saltwater wetland in the system with the largest single tract adjacent to Rock Island Cove at the mouth of the Weymouth-Fore River. Species such as the smelt, that utilize the marsh as a nursery, are also important in the biological communities of Town River Bay, Weymouth-Fore River, Hingham Bay and Quincy Bay.

In addition, the Town River marsh provides some storage capacity for floodwaters, and the grasses and other biological activity in the marsh provide a means of natural treatment or purifiction for the surface water runoff from the highly urbanized area.

Other Natural Resources

A small bed of softshell clams exists at the mouth of Town River. The bed is not harvested and represents only a minor fraction of the resources in the region. Clam beds throughout Hingham Bay have been contaminated in recent years. Approximately 95 percent of the area's clam beds have been moderately to grossly contaminated and closed to digging by the Massachusetts Department of Environmental Quality Engineering. Town River Bay contains only 50 acres of productive clam flats or approximately 15 percent of the total Quincy flats. In 1970, however, the Town River Bay flat contained more than 50 percent of the legal sized uncontaminated clams in Quincy and yielded a commercial harvest of some 450 bushels (approximate value, $5,000).

The upland portion of the watershed, above Quincy center, contains plant and animal life normally associated with an urban or suburban setting. In the residential areas within Braintree and above the reservoir, there are many species of songbirds and some species of small game such as rabbits, squirrels and pheasants. Within Quincy there are also many species of songbirds and some small game in the vicinity of the Blue Hills Reservation and Faxon Park. The remaining areas of Quincy have wildlife essentially associated with an urban environment, such as pigeons, starlings and English sparrows. Although the watershed has a wide variety of flora and fauna, no rare or endangered species were identified.

B. Effects Assessment on Natural Resources

The proposed and alternative flood control improvements would have minimal impacts on local and regional natural resources. Construction effects from building the proposed project would be temporary and would not severely impact the area's terrestrial or stream ecosystems. There would not be any long term construction effects on the smelt using Town Brook as a spawning ground. Temporary construction impacts on the environment are those normally associated with site development of a small project and would include stream siltation, some added dust and noise, and the removal of small areas of trees or other onsite vegetation. Any vegetation removed would regenerate

except for minor permanent displacement by project structures. The effects of the alternate nonstructural plan will have no adverse effect on natural resources.

The greatest potential for long term impacts from the proposed project is related to changes in water quality should flood bay waters remain in the tunnel for extended periods. Prolonged periods in the tunnel without thorough flushing could degrade the quality of water. The infrequent major storms with adequate flushing discharges will not produce serious impacts on the resources in Town River or the bay. However, the smaller more frequent runoff events that do not have sufficient flushing capacity could cause small and more frequent discharges of potentially anoxic tunnel waters for several days at a time. Structural measures will be provided to mitigate the water quality degradation in the tunnel and provide for monitoring the conditions in the tunnel. Further discussion of impacts on specific resources is presented below.

Blue Hills Reservation

No project improvements are proposed from the Blue Hills Reservation downstream to the Old Quincy Reservoir. Implementing the proposed structural or alternative nonstructural plan will not affect the reservation.

Old Quincy Reservoir

Construction and operation of the proposed outlet structure and emergency spillway will not adversely affect the existing ecosystems of the reservoir or of Town Brook below the reservoir. The water level may need to be drawn down several feet for construction, but, it is believed that emptying will not be necessary. The reservoir has a shallow 15-foot depth and has been maintained at a drawn down level (elevation 73.4 ft.) for flood storage. Its shallow depth causes a flat temperature gradient or fairly constant temperature regime throughout the reservoir.

The water temperature changes quickly in response to the seasons and stratification does not last long. Therefore, any need to lower the water level slightly during construction would not cause any unusual or long term impact. After construction the water level will be maintained at its present elevation.

The recommended project would cut through the upper section of the dam alongside the existing spillway to locate the new outlet and spillway works. This minimizes any effect on adjacent properties and reduces the number of trees to be removed. The existing spillway would be filled in to meet the crest of the dam. This action will not cause any adverse impacts to natural resources. The new outlet/spillway structure will be fitted with screening grates to prevent large floating debris from spilling into the brook and clogging its channel.

Construction of the recommended project may cause minor silting along the inside face of the dam. Any turbidity would settle out and remain in the vicinity of the disturbed area since there is little turbulence in the reservoir. Minor silting entering Town Brook would have little impact on the stream's

scant aquatic life. Construction during smelt spawning season will be carefully monitored to insure no adverse impact on the spawning grounds a couple miles downstream. The proposed work at the reservoir is expected to have no long term negative effect on the ecosystem of Town Brook.

Old Quincy Reservoir to Tunnel Inlet Structure

There is no plan for improvement on this section of the brook. There is, however, a Metropolitan District Commission (MDC) plan to enlarge existing conduits passing under residential roads and to widen the channel between Common Street and Route 3. They also propose to construct relief conduits from Centre Street to the Corps of Engineers proposed tunnel inlet. Although these diversion conduits will carry floodwaters through this area, the existing channels and conduits will continue to transport normal flows.

The tunnel inlet would be located off School Street behind the Star Market, adjacent to the MBTA rail tracks and the proposed Bergin Parkway. The inlet structure will cover a 2,000-square foot area measuring 40 feet by 50 feet. It will be placed (see Figure F-2, Appendix F) alongside the existing stream so as not to interfere with the flow line of the existing stream. Inlet design will allow normal flows to follow the present Town Brook channel through the existing conduits. Flows would continue to pass beneath Quincy, through the smelt spawning grounds and out the lower reaches of the stream. At this time it is expected that the design would allow floodwaters to enter the tunnel inlet shaft when the flow exceeds 100 cfs (cubic feet per second). This volume would still supply sufficient water for the stream's flushing action and would continue to provide water depth greater than 2 feet for the smelt spawning area. Normally, the depth of water in the spawning section of the stream averages 0.5 to 1.5 feet with less than 50 cfs flow. The spawning grounds and spawn should benefit by having floodflows pass into the tunnel rather than through the existing channel where flooding could wipe out the spawn.

Construction of the inlet tunnel and shaft will not affect any natural or significant terrestrial habitat. The site is in a highly altered and urban environment. The principal impacts are to the stream and would be short term and construction related. Approximately 50 feet of stone wall along one side of the channel would be removed and replaced by a concrete inlet structure. Construction will disturb the stream bottom and sides of the channel and cause silting. This could last from 2 to 4 weeks until concrete forms or temporary retaining walls are in place. No significant impacts will occur to the smelt spawn as long as the work does not occur during the spawning season, normally April to mid May.

During project design, construction methods and schedules will be reviewed and arranged to cause the least disruption. Among methods that will be assessed are off season construction, building "in-the-dry" and removing the channel wall after structures are complete, removing a section of channel wall and replacing it with a temporary retaining wall or concrete wall forms, diverting the stream around construction, and ponding the stream to create a sedimentation basin and subsequently removing the silt.

There should be little impact from silt buildup released from the small construction area downstream of the inlet site. The stream maintains a constant flow and sufficient energy to carry the silt out into the tidal area, where it would be dispersed by large volumes of sea water. There will be no significant smothering of streambed benthos or tidal shellfish areas.

Construction of the inlet and outlet shafts and the deep tunnel (190 feet below the surface) will not impact on any natural resource except for the removal of approximately 25,000 cubic yards of bedrock. Removal of the rock through this area will not affect the natural environment.

Downtown Quincy to Revere Road

Th proposed project would not adversely affect any natural resources in this area. The tunnel would be 190 feet or more beneath the city of Quincy.

Revere Road to Elm Street

The Corps of Engineers does not propose any structural improvements for this section of Town Brook. The prime smelt spawning areas that occur in this portion of the brook are not expected to be impacted provided mitigative measures are taken at the inlet construction site.

Elm Street to Town River Bay

The outlet for the proposed tunnel will be located in the area between Washington Street and the Southern Artery and will open into the salt marsh by way of a trapezoidal channel. Construction of such a channel would remove approximately a quarter acre of a well-drained, sparsely wooded field and temporarily disrupt use of an adjacent baseball field. Although the outlet channel is adjacent to the wetland, only a small portion would be affected during construction. The flow exiting the outlet would be about 1,100 cubic feet/second for a 100 year storm. Such high water velocities may remove or damage wetland plants or animals in the line of flow. Mitigation measures such as flaring the channel, energy dissipators near the outlet, or matting the wetland near the outfall area may be developed during Phase I design.

Other impacts on the natural resources in the area are dependent on the quality of the water exiting from the tunnel. The intermittent influx of storm water into the inlet and seawater into the outlet will keep the tunnel filled almost all times.

Accretion of organic matter associated with these influxes will generally increase the Biological Oxygen Demand (BOD) of the tunnel water so that anaerobic conditions are likely to prevail if the tunnel is not peridically flushed. Under these conditions, septic odors, hydrogen sulfide and methane gas would be produced. In addition, iron and manganese are converted to soluble forms. Such conditions will probably cause odors to emanate from the outlet. If these anaerobic waters are released from the outlet by small but frequent runoff events, the low dissolved oxygen may be deleterious to wetland species in the line of flow. Dissolved hydrogen sulfide gas also may be lethal to

them. A monitoring program can be developed during Phase I AE&D to determine the nature and degree of the problem. Recommendations for mitigation measures such as air bubblers or water recyclers will be based on the results of this study.

Downstream of the salt marsh, the Town River flows under the Southern Artery to the tidal inlet via two 72-inch pipes. Facilitation of outflow of the combined floodwaters from the Town River and the tunnel will require replacement of the pipes with three 8-foot x 14-foot box culverts. In addition, the left bank along the inlet will be graded back to further facilitate outflow. Construction work in this area will cause temporary siltation, which may have deleterious effects on the nearby shellfish beds. As mentioned earlier, these beds are not harvested and represent a minor fraction of the total regional resource. Grading back the bank will increase the area available for softshell clam habitat.

Widening the inlet into Town River will increase the inland area exposed to seawater during high tide. This may have a deleterious effect on nontolerant inland and freshwater flora and fauna that were not previously exposed to saltwater. Flap gates at the outlet of the box culverts will restrict the inflow of seawater entering Town River to its previous levels.

Appendix H

Social and Cultural Resources

APPENDIX H

Social and Cultural Resources

Social Well-Being Components	
Plan A, Relief Tunnel	1
Effects on Health, Safety, and Community Well-Being	
Effects on Educational, Cultural, and Recreational Opportunities	
Effects on Community Growth/Future Land Use Development	
Displacement of People and Businesses	
Plan B, Nonstructural	3
Effects on Health, Safety, and Community Well-Being	
Effects on Educational, Cultural, and Recreational Opportunities	
Effects on Community Growth/Future Land Use Development	
Displacement of People and Businesses	
Cultural Resources	6
Summary	
Survey Report	

Social Well-Being Consideration of the Detailed Project Plans

Social well-being considerations of a project alternative include most project effects traditionally termed intangible. According to the Water Resources Council's Principles and Standards, a plan's effect on social well-being is best described in terms of its effects on health, safety and community well-being, effects on education, cultural and recreational opportunities, and some indication of the probability of a project's causing community disruption or injurious displacement of people. This listing is not inclusive; social elements cover such a broad range, any given project alternative could have unique aspects which fall into this category.

Reduction of flood damages along Town Brook, particularly within Quincy's central business district, has been the major objective throughout this study. Several alternatives were dropped from consideration when their contribution to this objective was not significant (See Appendix B). This left one structural and one nonstructural plan for more detailed assessment. The structural plan, identified in the Main Report as Plan A, includes modification to the Old Quincy Reservoir and a tunnel extending a distance of 4,060 from Star Market/School Street to Town River Bay. The ultimate selection of the outlet site was also made through an examination of several optional locations, with one site being selected for incorporation into Plan A. The nonstructural plan, Plan B, is basically a flood proofing plan supplemented with a flood forecasting, warning and evacuation program and flood insurance.

A. Plan A

Areas specifically affected by the bypass tunnel alternative include the inlet and outlet sites, the Old Quincy Reservoir area, and the protected area. Implementation of this structural plan raises a number of social considerations specific to these places. Adverse impacts expected to be felt during the construction phase involve disruption of normal activities within and around the four areas. These impacts are temporary and would not result in long term effects. The most significant beneficial impact is the flood control protection that satisfies the planning objective.

1. Effects on Health, Safety and Community Well-Being

Adverse effects on the health and safety of community residents would be felt from the construction activities. All the construction sites are within developed areas and would be sensitive to construction impacts, such as increased noise and dust levels, increased use of local roads and increased heavy truck traffic. Construction at the Old Quincy Reservoir poses a safety risk to students at the Lakeside School. Activity around the outlet site creates a hazard for children using the Monroe Playground.

The movement of equipment and materials to the sites would occur on residential streets and through some congested commercial areas, increasing the accident risk along those roads. Some rerouting of traffic around or through residential areas may be required. More serious effects would be felt

along the Southern Artery with the construction of a new culvert. The Southern Artery is a four laned north-south highway giving access into Boston. It is most heavily traveled during the morning and evening commuter hours. It may be possible to maintain three traveling lanes by phasing the culvert construction. The middle lane would be reversible to handle peak traffic flowing northbound in the morning and southbound in the evening. If it becomes necessary it would be possible to detour traffic, adding a quarter mile of travel between the intersections of the Southern Artery with Washington Street and McGrath Highway. These traffic inconveniences would last for the estimated six months to one-year construction time.

Over the long term, the implementation of this structural alternative would be beneficial to community well-being and would reduce the health and safety risks faced by residents during a flood event.

Economic losses prevented are identified in Appendix I of this report. Annual flood losses of $2.1 million (April 1980 price levels) would be reduced to $92,000 in residual losses. The project can be expected to significantly reduce flooding from the 100-year flood event. Under severe conditions some low spots would collect water, but no substantial damages are expected. Therefore, the damages in Brook Road, Shopping Center and Bigelow Street Pools will be eliminated.

Disposal of tunnel material must be considered as part of the overall project. At this stage, land sites are felt to be most practical, but the use of land disposal sites raises several issues relating to public health and safety. Transporting the material to the disposal site would increase exhaust emissions and noise levels. Heavier truck traffic results in additional accident risk and safety hazard. The precise location of the site, its proximity to other uses, and the density and type of development along access routes would determine the severity of these effects.

2. Effects on Educational, Cultural and Recreational Opportunities

Construction-related effects would be felt by the Lakeside School and the Monroe Playground with implementation of this project. It is expected that children would still be able to use the playground with one less baseball diamond during construction. Over the long term, the project would eliminate flooding problems currently experienced by the Lakeside School, which is adjacent to the Old Quincy Reservoir. The flood threat would also be eliminated from the school playing fields located within the Brook Road Pool.

3. Effects on Community Growth/Future Land Use Development

Recurring flooding has been recognized as a hazard by those considering new development in the downtown area. Diverting floodwaters from the downtown would eliminate this concern as development of the retailing/office/hotel complex is undertaken because implementation of the structural plan complements these plans for development. Although it appears development planning would proceed without the Corps project, some provision for managing the flood situation would be required in the planning process for the mall complex.

The project requires the acquisition of 5.64 acres of land in total for the inlet and outlet shafts sites including some wetlands in the vicinity of the outet site. This acquisition is not expected to impact future land use development on a significant economic effect.

Disposal of material displaced by a tunnel raises several issues related to future land use development. Local residents often express disapproval of a land disposal site because of its unappealing appearance and effect on property values of nearby real estate. The creation of a disposal site can eliminate as well as limit the use of the site for another type of activity.

4. Displacement of People and Businesses

Implementation of the structural plan would not require any residential relocations. However, approximately 35 permanent subsurface easements would be required of private ownerships. These easements are not anticipated to affect the use and value of surface or near-surface inground improvements.

Temporary construction easements would be necessary at the inlet and outlet locations except where city property is involved. In addition, 5.64 acres of land at these two locations would be taken in fee. This acreage is vacant at the present time.

The construction at the outlet site and the Southern Artery will result in inconveniences to one commercial establishment, the HI-LO grocery on the Southern Artery. Culvert construction to handle increased flows in Town River is necessary in this area. This construction would require the taking of an easement through the store's parking lot during the placement of the new culvert. Options being considered to lessen the impact include providing alternate parking for store customers and staging construction.

B. Plan B

The nonstructural plan that has reached this detailed iteration combined flood proofing techniques with flood forecasting, warning and evacuation plan, and flood insurance. The two flood proofing techniques considered to be most effective for homes in the Town Brook flood plain are utility cells and ringwalls. Other flood proofing measures, including replacing foundations with reinforced concrete foundations, providing a second foundation wall, water proofing exterior foundation walls and rearranging damageable property within the structure, were also examined. Commercial establishments, specifically those in the downtown area, would have to rely on flood insurance for relief from economic damages. Flood insurance could prove to be worthwhile investment for homeowners, too.

1. Effects on Health, Safety and Community Well-Being

The nonstructural plan would have some positive contributions to the health, safety and community well-being of Quincy's residents. Effective implementation of the flood warning and evacuation element of this plan should provide for the safe removal of residents from the threatened area. The flood warning and evacuation element is the key item in the nonstructural plan's ability to protect lives, whereas the other elements in the nonstructural plan generally protect against economic losses.

The nonstructural plan recommends the construction of utility cells in many of the residential structures within the flood prone areas. Although damages to the property would not be eliminated, the major utilities would be protected. Complementing this protection with the purchase of flood insurance would reduce the economic risk. Other residential structures, especially some of those close together in the Brook Road Pool, would be protected by the construction of reinforced concrete ringwalls around clusters of homes. Residents, however, would have to be evacuated during a flood.

Where flood proofing would not be feasible or does not prevent water entry (as in the case of utility cells) flood insurance would provide economic relief. The investment in flood insurance appears particularly worthwhile for the commercial establishments in the Shopping Center Pool, where no practical use of flood proofing measures could be made. Again, the purchase of insurance for individual residences would also provide some peace of mind against potential economic losses.

Although Plan B would reduce economic losses and provide for timely removal of residents from the flooded area, flooding would still occur. Inundated roads would cripple normal activities. Emergency services would still be required for efficient implementation of the evacuation plans.

2. Effects on Educational, Cultural and Recreational Opportunities

Plan B would have limited effects on the education, cultural and recreational opportunities within the Town Brook flood plain.

Recreation is generally considered a good use of flood prone lands. Therefore, the nonstructural plan would not protect flood plain recreational areas, the Monroe Playground and the Lakeside School playing fields. These areas would continue to be inundated, limiting their use during floods and for some time thereafter.

Flood proofing measures can reduce damages to Lakeside School, but it would have to be evacuated and closed down in the event of a flood.

3. Effects on Community Growth/Future Land Use Development

Because Quincy and, in particular, its flood prone areas are already intensively developed, the nonstructural plan is not expected to have any significant effects on community growth or future land use development.

Plan B enforces Quincy's participation in the flood insurance program. Quincy is already enrolled in the regular phase of the program and therefore has adopted regulations controlling the use of the Town Brook flood plain.

4. Displacement of People and Businesses

The nonstructural plan would require the removal of residents during a flood event. Although flood proofing may keep water out of individual structures, occupants would not be left in locations cut off from needed utilities and services. Residents temporarily removed from their homes would be provided emergency shelter and food through a program of emergency services. This situation creates tremendous inconvenience and severe disruption to the routines of all residents evacuated. It is estimated that residents would be able to return to their homes within 1 to 2 days after the flooding event, at which time stores would be able to reopen.

CULTURAL RESOURCES

Summary

The following report was performed for the New England Division in 1976, by a team of consultants from Harvard University. It consists of a cultural resource reconnaissance for impact areas identified under the planning alternatives at that time. Due to subsequent changes in plans, a number of their recommendations for further study no longer apply. The following summary is intended to clarify the report's recommendations in light of current plans.

The project section involving a low dike and spillway adjacent to the Old Quincy Reservoir (Areas 1 and 2, in the contractor's report) is recommended for more detailed survey to locate any prehistoric sites which may exist in the area.

The present plans involve modification of the existing dam, by either the Federal Government or local interests. As there are numerous dams of similar construction, vintage, and better condition in the region, no effects upon significant historic resources are anticipated due to dam modification.

The section between Route 3 and the Liberty Street area (Areas 6, 7, & 8) has been removed from consideration in current plans. Therefore, no further cultural resource studies are planned for this section.

The plans for channel widening between the McGrath Highway and the Southern Artery (Area 11) have been modified to avoid widening, and to incorporate a tunnel outlet near its western end. Therefore, only about 50 feet of the former Quincy Canal towpath would be disturbed. As the towpath is in extremely eroded and disturbed condition and only a short segment would be modified, no impacts upon significant cultural resources are anticipated under current plans.

The project section of the Southern Artery (Area 12) includes a ruined lock basin of the Quincy Canal (c. 1824). This is a timber and stone structure in deteriorated condition, with small boat basins adjoining its upstream downstream sides. A 19th century tidemill structure stands immediately east of the lock, but is outside the impact area of the project. It is anticipated that the lock structure may be impacted by channel widening in this area. Therefore, in the next stage of project planning, the Corps will seek a determination of eligibility for the National Register of Historic Places for this structure. If the lock is determined eligible, plans will then be undertaken for mitigation of the project impact upon the lock remains.

In summation, at the next stage of project study the following cultural resource activities are proposed:

(1) Detailed archaeological site survey in the area of the proposed dike and spillway near the Old Quincy Reservoir, to locate and assess the significance of any archaeological resources which may exist in the area.

(2) A determination of eligibility will be sought for inclusion in the National Register for Quincy Canal lock structure near the mouth of Town Brook. If the structure is determined eligible, planning for mitigation strategies will be initiated.

REPORT OF A CULTURAL RESOURCE

SURVEY OF THE TOWN BROOK

FLOOD CONTROL PROJECT AREA

Contract # D A C W 33-76-M-1197

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June 1, 1976

I. SCOPE OF PROJECT

This report is the result of both archival and field research undertaken for the United States Army, Corps of Engineers, New England Division, during May, 1976. The survey area is the area to be disturbed by the proposed Town Brook Flood Control Project, within the cities of Quincy and Braintree, Massachusetts (see Map 1). The area has been highly disturbed by modern urban settlement and watercourses have been altered significantly by rechanneling and land reclamation.

The primary goals of this survey were two:

1. To locate and assess the significance of sites on the tract to be disturbed by the project; and
2. to make recommendations for the future management of cultural resources located.

In addition, an overview of the cultural resource potential of the region, both prehistoric and historic, is presented.

II. OVERVIEW OF REGIONAL CULTURAL RESOURCE POTENTIAL

For the greater part, information pertinent to this section is the same as recorded in the similar section of a report on the Furnace Flood Control Project (Barber and Essenpreis 1976:2-8). Therefore, at the suggestion of Mr. Richard Anuskiewicz, Archaeological

Officer for the New England Division, U. S. Army Corps of Engineers, this section will include only a summary of that information. Other details pertinent to Town Brook and not Furnace Brook, however, will be included.

Regional aboriginal prehistory began some 12,000 years ago with Paleo-Indian occupations, followed by occupations usually classified as Archaic, Transitional, Early Woodland, Middle Woodland, and Late Woodland. Dincauze (1973) has shown sites from various of these culture periods in the nearby Neponset River valley.

Historically, Wampatuck's band of the Massachusett controlled this area and sold their holdings to Great Britain in 1665 (Speck 1928:97); the deed resides in the vault at the Braintree Town Hall. The local Indians were known locally as Maspatusucks (pers. comm., H. Hobart Holly, George Horner, 4/24/76). These Indians were totally reduced by the epidemic of 1616-1617 and emigration following King Philip's War in 1675.

Europeans first visited the area in the mid-sixteenth century for trading and fishing. An English trading post was established at Merrymount in 1625, but a permanent settlement was first made at Mount Wollaston in 1634. Braintree and Quincy were a political entity between 1640 and 1792, when they split to form separate towns.

The area west of Adams Street in Quincy and to the south in Braintree is the old quarry district. Quarrying began in 1815, although loose chunks had been used in the rough for building since 1666 and had been dressed since 1749 (Edwards 1957:120-121; Wilson 1906:52). Before 1825, granite was considered only suitable for rough work, but the erection of the Bunker Hill monument in 1826 established granite as a prestigeous building stone and touched off economic development in Quincy.

In an attempt to facilitate granite transport, Joshua Torrey began the Quincy Canal Corporation in 1824, completing a canal along Town Brook from the tide mill at its mouth to the Hingham and Quincy Turnpike in 1826. The venture was an economic failure and closed shortly thereafter (Anonymous 1926:9; Pattee 1878:104).

The Granite Railway, owned by several of the quarry owners, ran from the quarries to the Neponset River. Beginning in 1826, this venture was a success, the first incorporated railway in North America. The roadbed was made of crushed granite to below the frostline; ties were originally wood, but were replaced within 7 years by granite ties (Anonymous 1926:14-15), some of which now are on the Adams Academy lawn in Quincy.

The Old Quincy Reservoir in Braintree was built privately by the Quincy Water Company in 1883 and bought by the Town of

Quincy in 1892 (pers. comm., Owen Eaton, 5/14/76). While no further records have been located or are known to exist, a sonar study of the reservoir bottom by Hazeltine Corporation in August, 1962, revealed a bottom consistent with the topography as indicated on old maps (Chisolm 1940; Sprague 1940). The conclusion that fill for the dam came from outside the reservoir area is further supported by local reports of stone walls and wooden farm machinery becomming visible at low water periods.

Maps by Chisolm (1940) and Sprague (1940) of the area in 1640-1645 show several landmarks, some of which are near the survey route. The Thomas Faxon house (1945), the William Ames mill (1641), and the Francis Ellyott house (1638, 1644) all lie close to the survey route, although not within it.

III. ARCHAEOLOGICAL RECONNAISSANCE

The methods used in the field reconnaissance of the Town Brook area were to walk over the portion to be affected by the proposed U. S. Army Corps of Engineers' program and take corings in an attempt to determine whether various portions of the route were greatly disturbed or relatively intact. If disturbed, the nature and approximate period of disturbance were determined and no

further work was done by us in these areas. The results of the borings taken for the Corps and included in the draft report to the Commonwealth of Massachusetts Metropolitan District Commission (Metcalf & Eddy, Engineers 1976) were then checked for cooroboration with the results obtained in our study. Subsurface testing in the form of 0.5 meter square test units was undertaken in six different locations which were determined to be most sensitive and most likely to produce cultural remains. The results which we obtained indicate that the Town Brook area surveyed became of significant historical interest in the 1820's with the building of the granite railway and the canal on the Town Brook/River. Artifacts relating to the canal period were found at the Town River and will be described and discussed in the following section.

Area 1 (see Map 1) extends along the proposed earthen dike along the north side of the Old Quincy Reservoir (along Lakeside Drive) to the proposed spillway weir and outlet works. The western-most portion of the area was difficult to examine due to heavy undergrowth. Cores taken approximately every 20 meters along the proposed dike showed yellow sand to at least 45 cm. B.S. (below surface) beneath 10 to 30 cm. of brown humic loam. No cultural materials of prehistoric or early historic origin were recoverd. However, inhabitants of the area mentioned seeing old stone walls

and farm equipment at the bottom of the reservoir when it dried up several years ago. The eastern portion of this area beginning opposite the Jordan Marsh entry-road was extremely disturbed with exotic gravel forming a parking lot over part of the area. The rest of the area had been stripped of topsoil and was fairly open. About 15 to 30 meters back from the shore of the reservoir, an exotic fill bank is raised up to 4 meters high. The area is relatively high above water table and in general is the most likely portion of this area to produce cultural material of both prehistoric and historic interest. Our survey indicated that the westernmost portion is relatively undisturbed; therefore we dug Test Unit 4 about 20 meters from the shore (see Map 2). The stratigraphy (see Profile 4) was as follows:

Stratum	Description	Depth, B.S.
1	Humus	0-14 cm.
2	Yellow sand	14-40 cm.

Neither artifacts nor disturbance were encountered, but the testing was of such a limited nature that more extensive work should be completed before the dike is constructed.

Area 2 consists of the lowlands just east of the Old Quincy Reservoir and includes the area where the spillway weir and outlet works, the spillway channel and chute, and the stilling basin are to be built (see Map 1). Most of this area was impassable and

without room to core; the vegetation was very thick. The area near the brook was examined and cored. From 5 to 8 cm. of humus overlies a very loose, wet, yellow sand; the water table is very high, within 5 cm. of the surface. A boring (D-23) taken near the area examined showed fill down to a depth of 1 foot and brown sand down to 5 feet. Since the vegetation prevented us from doing a thorough survey of this area, we recommend that a future examination of the area be made when the undergrowth has been cleared, but prior to any earth moving operations.

Area 3 consists of a culvert running under Walnut Street and is completely disturbed by the existing culvert and landscaping activities. No further archaeological work is required for this area.

Area 4 begins just west of Acorn Street and passes under a driveway just east of Acorn Street. This area is also heavily disturbed; no further work is recommended.

Area 5 runs from Town Brook at the corner of Howie and Marcia Streets to the northeast of Route 3. From Howie Street to Common Street the culvert runs under a hedge of roses and a lawn. From Common Street to Route 3, cores and surface indications showed severe disturbance. No further work is necessary in this area.

Area 6 runs from northbound Route 3 to the railroad and along

the railroad until the point where the route diverges from the railroad. The portion from Route 3 to the railroad was higher, relatively dry ground. Coring gave the following sequence:

Description	Depth, B.S.
Humus	0- 8 cm.
Gray-brown silt	8-10 cm.
Yellow-brown clayey silt	10-20 cm.
Gray sandy silt	20-45+cm.
Water table	45 cm.

We encountered an old stone wall (see Map 3; Plates 2,3,4) made of granite blocks, some of which showed hand chisel marks. We followed the wall to the brook to the east and to another stream to the west. The probable function of this wall was that of field boundary marker, although that conclusion is not incontestable. A date of 1803-1831 is suggested, based on cur knowledge of granite technology (see Section IV.). The wall runs approximately east-west and crosses the proposed channel route.

Test Unit 5 (see Map 3) was dug just south of the wall and 20 meters west of the east brook and gave the following sequence (see Profile 5):

Stratum	Description	Depth, B.S.
1	Humus	0-10 cm.
2	Gray sandy silt	10-14 cm.
3	Light orange sandy silt with small quantities of rock	14-24 cm.
4	Medium orange-brown silty sand	24-42+cm.

No artifacts were found, but if such could be found, it could provide further data for temporal placement of the wall. Therefore, we recommend that an archaeologist be present at construction work in the area near the wall.

The second section, adjacent to the Granite Railway, is low, swampy ground, possibly as a result of the drainage having been interrupted by the railroad. We encountered an undressed stone wall of indeterminate date, as well as an old roadbed to a railroad spur. Cores were taken where possible and indicated fill. A boring reported in the draft report (D-5) records fill to a depth of 5 feet, apparently the railroad bed. No further testing is deemed necessary along the railroad portion of the area.

Area 7 extends from the old Granite Railway to Liberty Street (see Map 1). The section from the railway to Centre Street runs through unsurveyable marshlands. Cores of this portion showed disturbance and the surface was littered with tarmac waste. The section from Centre Street to Columbia Street showed moderate surficial disturbance, but seems relatively intact. A boring for the area (D-7) showed fine sand with a little gravel down to 4.5 feet deep. However, surface disturbance in the form of modern waste granite material prevented us from making an adequate surface examination. Test Unit 6 was dug in this area (see Map

4), in which we hit a large block of granite at 10 cm. B.S. The stratigraphy (see Profile 6) was as follows:

Stratum	Description	Depth, B.S.
1	Humic loam	0-19 cm.
2	Pebble layer	19-24 cm.
3	Gray clay	24-30+cm.

Stratum 1 contained modern artifacts: part of a square glass milk bottle, green glass soda bottle pieces, brick fragments, and a piece of lead glazed sewer pipe.

Due to the surface disturbance in many portions, we suggest that an archaeologist be present during construction in Area 7.

Area 8 runs along Brook Road and is entirely paved over. A boring taken on Liberty Street where Brook Road intersects it (D-8) showed fill to a depth of 4 feet overlying what appears to be an old ground surface with gray organic silt, a little peat, and fine sand. If this old ground surface is to be disturbed, we suggest that an archaeologist be present during construction.

Area 9 runs along Liberty Street, angles eastward to the old Penn Central Railroad tracks, runs along the tracks to School Street, and ends at a parking lot behind the Star Market just east of School Street. This entire area is paved or highly disturbed and no further work is suggested.

Area 10 begins at Bigelow Street and includes the section which runs parallel to McGrath Highway. The section up to where

Town Brook has been channelized is under pavement and is moderately to heavily disturbed. The section along the channelized portion of the brook gave corings of loam over gravel at about 8 cm. B.S. It was possible to surface survey this latter portion, but no cultural remains were encountered. No further work is indicated.

Area 11 begins just east of McGrath Highway beside a nursing home parking lot and runs to the east side of the Southern Artery. The section next to the nursing home grounds shows disturbance: a paved level at about 20 cm. B.S. crops out in the bank. Just behind the parking lot, the area seems relatively undisturbed. A boring of this area (D-17) showed brown root matter and gray organic silt with a trace of shells down to a depth of 6.5 feet. We dug Test Unit 1 near the area bored (see Map 5) and found the following profile:

Stratum	Description	Depth, B.S.
1	Humic silt	0-10 cm.
2	Gravel (till-like)	10-40 cm.
3	Dark brown silty sand	40-45 cm
4	Orangish-brown very coarse sand	45-50 cm.
5	Gray coarse sand	50-55+cm.
	Water table	55 cm.

Stratum 1 contained both recent cultural material and nineteenth century items; stratum 2 contained only undiagnostic artifacts. Stratum 3 contained a molded glass bottle base dating to the early nineteenth century and a piece of vegetable tanned leather.

Strata 4 and 5 were sterile. (Section IV of this report gives details on these artifacts.) We have interpreted Stratum 3 as probably the former ground surface, overlain by glacial till used as fill during the construction of a droving trail for the Quincy Canal built in 1824. This probable trail exists as a series of fill structures, some with large granite blocks, which run along the southeast side of Town Brook. Gaps in the presumed trail may be due to erosion or later drainage control attempts. This area gets lower toward Town River, i.e. to the east, and the water becomes slightly brackish. A boring (D-18) on the southern edge of the area shows fill (of two different types) to a depth of 8 feet. To the eye, certain areas obviously were built up, whereas others could have been natural. We dug a second test unit (Test Unit 2) in this area (see Map 5), which showed the following profile (see Profile 2):

Stratum	Description	Depth, B.S.
1	Brown fine silty sand	0-15 cm.
2	Coarse mottled orange and gray sand	15-26 cm.
3	Slightly mottled gray silty sand	26-46 cm.
4	Coarse mottled orange and gray sand (as in Stratum 2)	46-53+ cm.

This unit contained mostly modern glass, plus three objects of indeterminate age: 1 piece cut leather, 1 brick fragment with

fused coal, and 1 piece of blue, unidentified material. These materials were dispersed throughout the top 3 strata. All material seems to be of modern origin. This unit was place on top of one of the hummocks which we suggest could be a recently disturbed portion of the droving trail.

Test Unit 3 also was dug in Area 11 on one of the few portions of the north bank of the former canal which is not under water at high tide (see Map 5). No artifacts were encountered, but the stratigraphy (see Profile 3) was as follows:

Stratum	Description	Depth, B.S.
1	Humus	0-12 cm.
2	Gravel (till-like)	12-26 cm.
3	Gray sand	26-32+cm.
	Water table	32 cm.

Area 11 is a highly sensitive area for two basic reasons: 1) this section represents one of the most significant ecological areas in the watershed in that it provides an area for smelt spawning and in that the salt marsh adjoining the channel provides a nutritionally rich habitat (Metcalf & Eddy, Engineers 1976: B-19, B-20) which could have attracted prehistoric man; 2) this portion was once part of the Quincy Canal and could contain a great quantity of historicall valuable material. Therefore, in spite of the disturbance of the surface and the addition of exotic fill, the area should be examined more intensively before

construction of the 100 foot wide channel.

Area 12 consists of the area to the east of the Southern Artery to Town River Bay. At the Southern Artery are remains of the dam and the tidegate structure associated with the Quincy Canal. The old tidemill building and the mill race structure still exist as the property of the Quincy Lumber Company (see Plate 1). It is our recommendation that these remains of the canal and the tidemill be left undisturbed and be preserved.

IV. ARTIFACT DESCRIPTION AND ANALYSIS

Two general classes of artifactual remains were located during the course of this survey: portable and non-portable. The former were collected, the latter observed in the field.

Portable remains: Some forms of portable remains were encountered in most test excavations and on much of the surface. The vast majority of these, however, have been modern, usually from within the last 30 years. Only older remains of greater archaeological interest are discussed here. Such remains came only from Test Unit 1 in Area 11.

Stratum 1 of Test Unit 1 contained 8 pieces of glass, 7 potsherds, and 1 piece of plastic. Glass pieces included a wall of a square

milk bottle (Plate 5A), from the late 1940's or early 1950's; a shoulder, neck, and rim fragment of bluish bottle glass from a quart mason jar (Plate 5B), after 1930; a thin rim fragment of bubbly and gritty clear molded glass, the offset rim of a jar of 8 cm. diameter, of unknown but non-modern date (Plate 5C); a thick piece of wall from a dark green blown wine bottle (Plate 6A), pre-1830; and 4 pieces of molded glass of unknown date (Plate 6B-E). Pottery consisted of 3 pieces of thick earthenware with interior lead and exterior tin glaze, 2 of which were rimsherds (Plate 7A,B), each with reconstructed diameter of 12.5 cm., and 1 of which was a basesherd (Plate 7C) of the same diameter -- these 3 sherds seem to be from the same vessel, a small crock, probably pre-1870's; a base and body sherd of a globular vessel, perhaps a vase, of creamware, decorated with a molded rope pattern at the foot and a faint pink and buff transfer printed rose design on the body (Plate 8), 1750-1840; a piece of transfer printed polychrome (Plate 9A), after 1750; a piece of modern frit porcelain (Plate 9B); and a piece of red, unglazed earthenware (Plate 9C), date and function unknown. The plastic piece is a modern button (Plate 9D). The assemblage from Stratum 1 ranges from the late eighteenth or early nineteenth century to modern times.

Stratum 2 of Test Unit 1 contained only artifacts of undiagnostic

date: 1 piece of red earthenware with coal (?) fused to it (Plate 1..., and two pieces of vegetable tanned leather (Plate 10B, C). One of these pieces (Plate 10C) is cut on all edges and seems to be manufacturing refuse, not merely a cast-off.

Stratum 3 of Test Unit 1 contained another piece of vegetable tanned leather (Plate 11B), of indeterminate age. The only other artifact from this stratum is the base of a small glass bottle (Plate 11A), probably a medicine bottle, 4.4 cm. wide and 2.0 cm. deep. The oblique view (Plate 12) shows the characteristic thickening of the foot and thickening at vertices associated with glass blown into a mold. Less clearly visible in the photograph but obvious on the specimen is the pontil mark in the center of the base. This technique was in vogue in the United States only between 1815 and 1835 (Cotter 1968:32) and was rapidly supplanted by pressing. Although no other artifacts were found, this diagnostic indicates the period 1815 to 1835 to fall within the time period of the stratum.

Non-portable remains: Two locations possess non-portable remains worthy of note.

At the mouth of Town River, in Area 12 just to the east of the Southern Artery, the remains of an old (pre-1826) tide mill are visible (Map 5; Plate 1). The wooden pilings and stone

abuttments appear to be either remains of that mill or a renovation of it.

The other locus of non-portable remains is the stone wall in Area 6 of the survey (Map 3; Plate 2). This wall's age is suggested by the large trees growing through it (Plate 3) and confirmed by its technology.

The lower portion of a granite block in the wall (Plate 4) shows clearly a series of wedge or chisel marks; no blocks show boring holes. Prior to 1803, the method for splitting granite blocks (then surface collected, not quarried) was to heat the rock, then drop large iron balls on it (Anonymous 1926:27; Pattee 1878:514; Wilson 1906:52). In 1803, Josiah Bemis, George Stearns, and Michael Wild first used hammers and iron wedges to split granite blocks (Anonymous 1926:27). In 1831, Joseph Richards began using the bush or axe hammer to dress granite and the Louis (drilled) hole to split it (Pattee 1878:514). Only in 1877 did sawing and polishing start coming into practice. In terms of the stone wall in Area 6, therefore, we can securely date the preparation of the split stone (Some blocks are in their natural state) to 1803-1831. The wall, however, may have been built later if the wedged stone were associated with the adjacent railway or its construction and re-used.

V. RECOMMENDATIONS

The following are our specific recommendations for future management of the cultural resources in the area to be disturbed by the Town Brook Flood Control Project:

Area 1: More extensive reconnaissance of the portion to be covered by the dike should be undertaken;

Area 2: After vegetation clearance, a surface survey and one test unit should be conducted;

Area 3: No further work recommended;

Area 4: No further work recommended;

Area 5: No further work recommended;

Area 6: In the area near the stone wall, an archaeologist should be present during construction; alternatively, a detailed archival search might disclose the type of land use in 1803-1831 -- the sensitivity of the area does not derive from the wall itself whose intrinsic value is minor or from a field whose boundary it may mark, but rather from the possibility that a structure was nearby;

Area 7: An archaeologist should be present during construction;

Area 8: If the former ground surface is to be disturbed, an archaeologist should be present during construction;

Area 9: No further work recommended;

Area 10: No further work recommended;

Area 11: More extensive test excavation should be undertaken on the south side of Town Brook to determine more thoroughly the extent and content of canal period undisturbed land surfaces;

Area 12: Tidemill structures should remain undisturbed.

Of the entire survey route, Areas 11 and 12 are the most sensitive.

Information on locations for proposed spoil disposal areas, walkways near the reservoir, staging areas, and fill sources was not available to us during this survey, but such areas should be surveyed before construction takes place. No archaeological survey can guarantee total recovery of site locations; if sites should be discovered in areas previously deemed unlikely, an archaeologist should be consulted.

Our cost estimate for implementation of our recommendations is $ 3500.

VI. BIBLIOGRAPHY

Anonymous.
1926 The First Railroad in America: A History of the Origin and Development of the Granite Railway at Quincy, Massachusetts. Private printing for the Granite Railway Company. Boston.

Barber, Russell J. and Patricia S. Essenpreis
1976 Report of a Cultural Resource Survey of the Furnace Brook Flood Control Project Area. Report submitted to The U.S. Army Corps of Engineers, New England Division.

Chisolm, Ivan A.
1940 Old Braintree Map. Privately published. Braintree, MA.

Cotter, John L.
1968 Handbook for Historical Archaeology, Part I. Wyncote, PA.

Dincauze, Dena F.
1973 Archaeological Reconnaissance in the Greater Boston Area: 1969-1972. Report to the National Science Foundation.

Edwards, William Churchill.
1957 Historic Quincy, Massachusetts. City of Quincy, pub. Quincy, MA.

Metcalf & Eddy, Engineers.
1976 Report to Commonwealth of Massachusetts Metropolitan District Commission: Flood Control Systems for Town Brook, Quincy and Braintree. Draft report.

Pattee, William S.
1878 A History of Old Braintree and Quincy. Green and Prescott, Quincy, MA.

Speck, Frank G.
1928 Territorial Subdivisions and Boundaries of the Wampanoag, Massachusett, and Nauset Indians, Indian Notes and Monographs, Misc. Series. No. 44.

Sprague, Waldo C.
1940 Old Braintree (Including North Quincy and Squantum), 1640-1645.

Wilson, Daniel Munro.
1906 Quincy, Old Braintree, and Merrymount: An Illustrated Sketch. George H. Ellis, Co., Boston.

APPENDIX: E.I.S. CHECKLIST => FOR INTERNAL CORPS USE, SEE INCLOSURE #2 FOR LIST

1A-2I. Not applicable.

2J. The historical and archaeological features present in the area to be directly affected by the project include the Granite Railway, the Quincy Canal, and the old stone wall mentioned in Section III. We were unable to locate evidence of aboriginal occupation, but due to extensive areas being covered by recent fill, such remains may exist.

2K-2O. Not applicable.

3A. No conflicts have been noted by us between the proposed action and existing land use plans.

3B-4F. Not applicable.

4G. The proposed project will require a limited amount of further archaeological work in order to guard against accidental disturbance of archaeological sites, but no major mitigation measures are deemed necessary.

4H. Not applicable.

5A. Adverse effects in terms of the historical and archaeological features are negligible.

5B. Every care should be taken to minimize the effect of the proposed plan on the canal elements and the tide mill in Town River Bay.

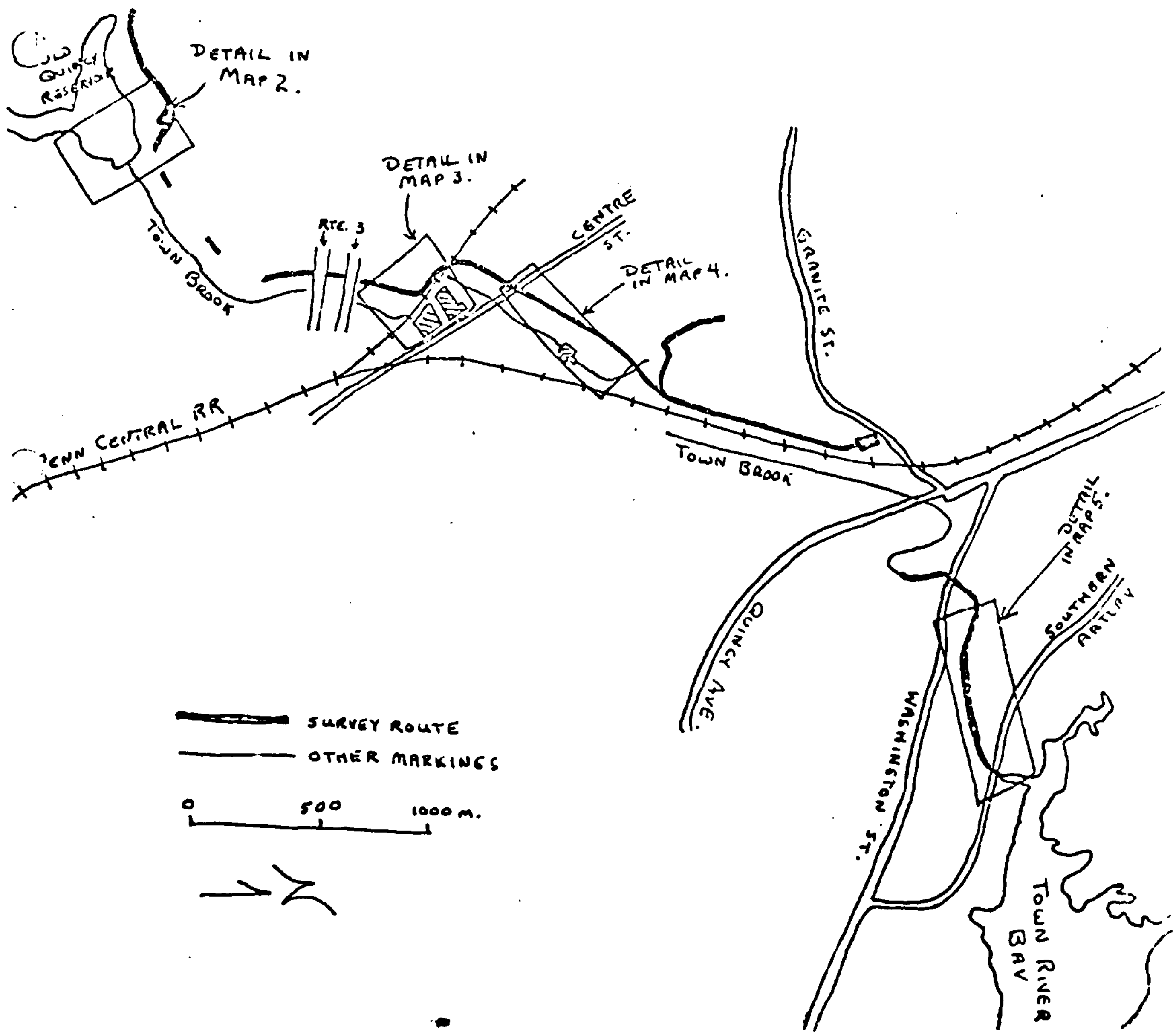
6A-6D. Not applicable.

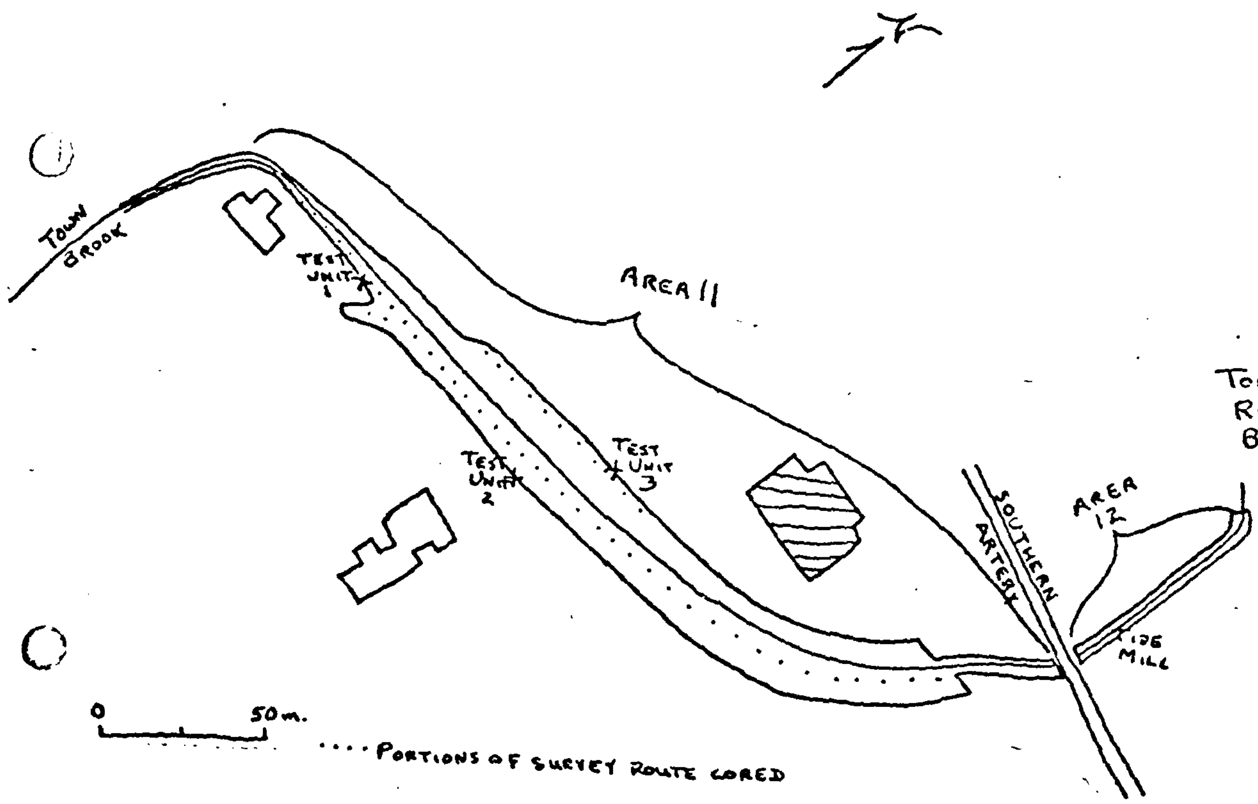
7A. In terms of long-term impacts, any action that destroys an archaeological or historical feature is irrevocable.

7B-8B. Not applicable.

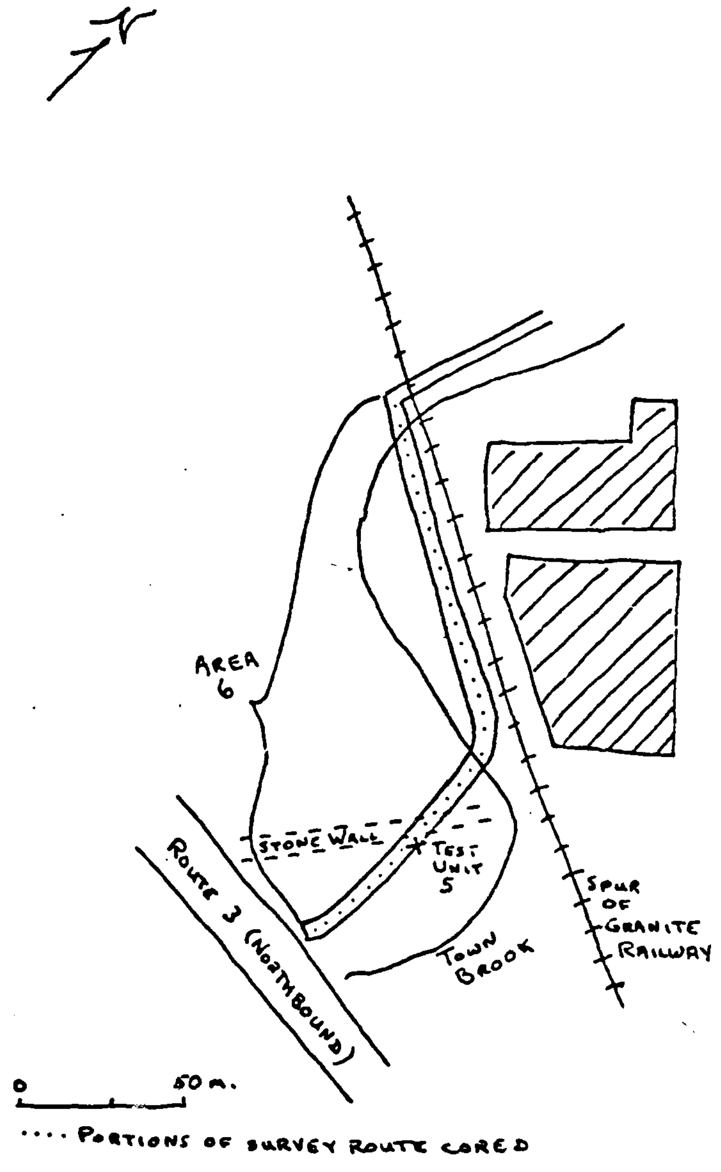
8C. The proposed action involves the destruction of a portion of the old railway bed and part of an old stone wall and involves irreversible changes in the old canal channel.

MAP 1. SURVEY AREA, TOWN BROOK FLOOD CONTROL PROJECT.

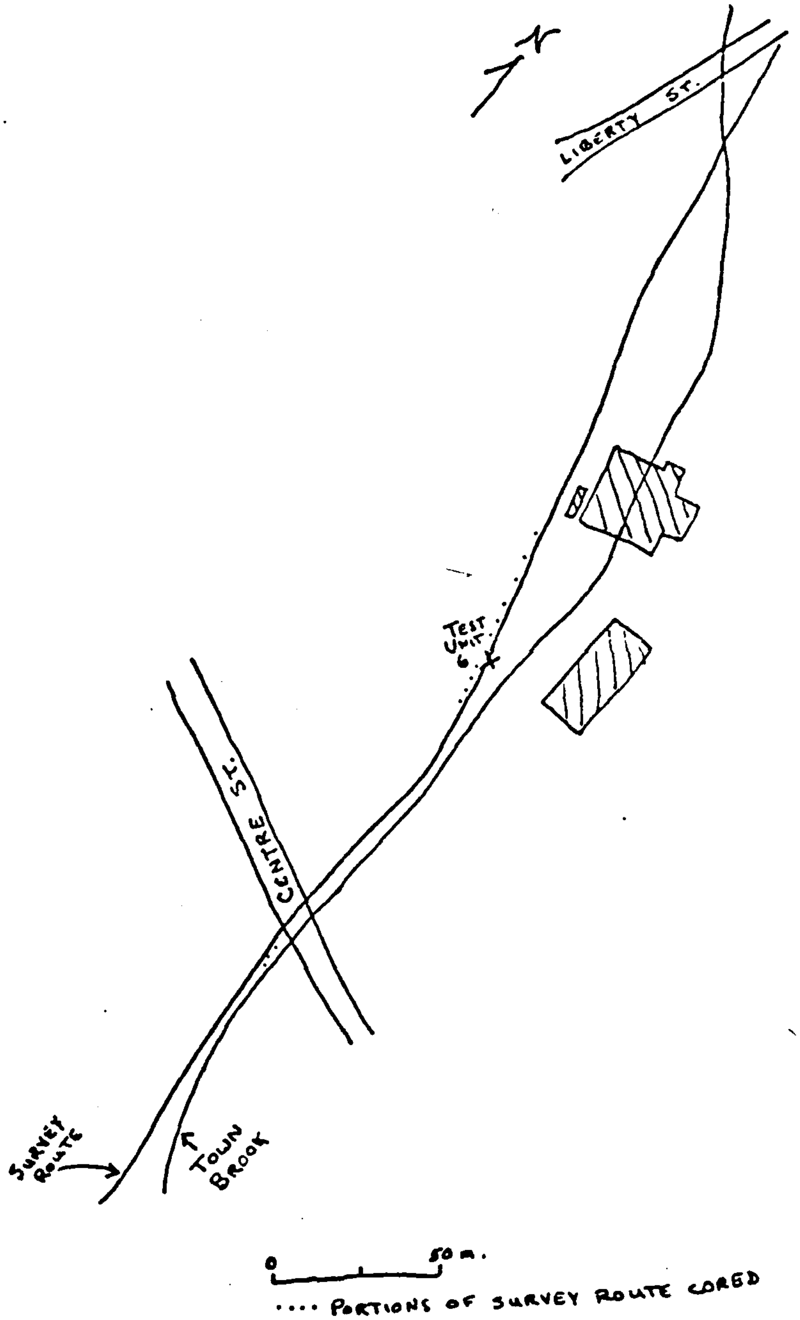




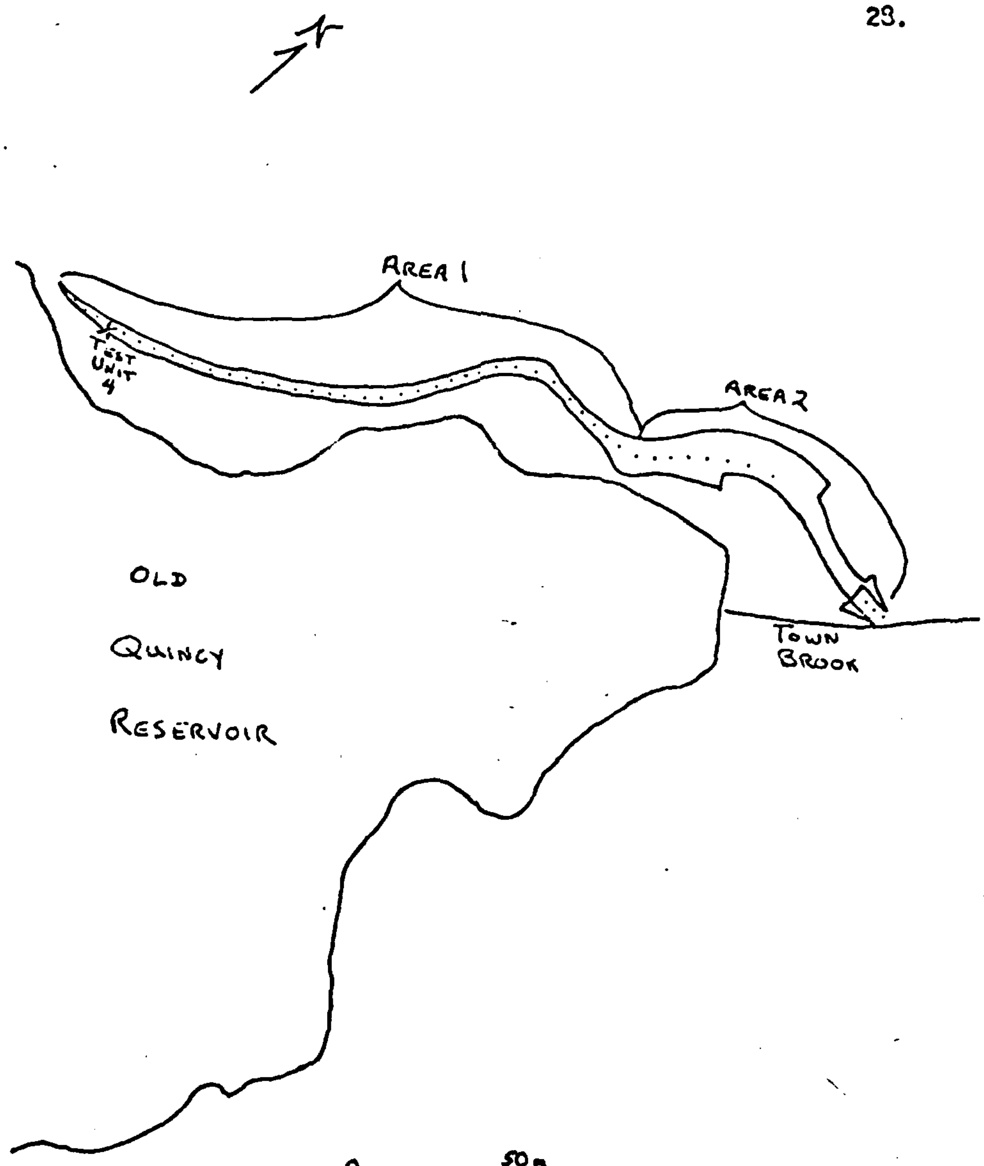
MAP 5. AREAS 11 AND 12.


AREA 6
STONE WALL
TEST UNIT 5
SPUR OF GRANITE RAILWAY
TOWN BROOK
ROUTE 3 (NORTHBOUND)
0
50 m.
.... PORTIONS OF SURVEY ROUTE CORED

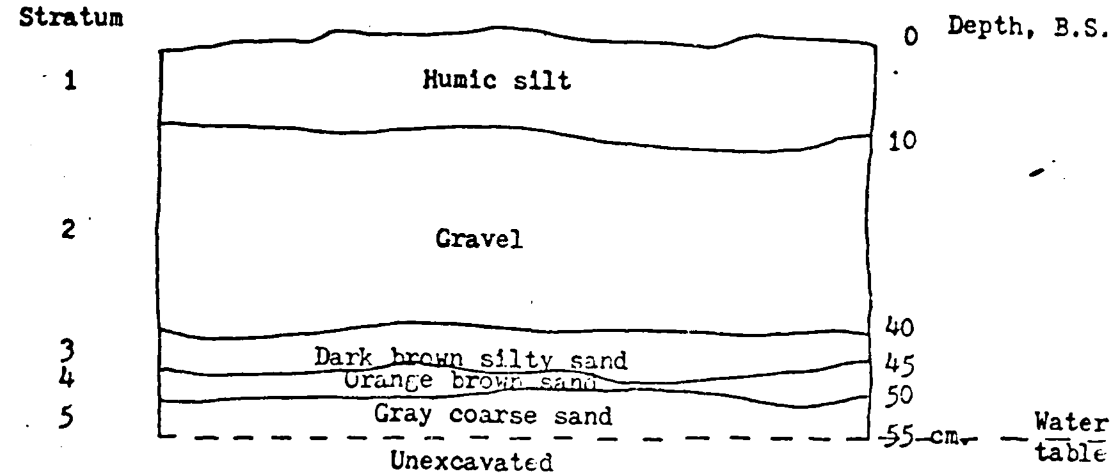
MAP 3. AREA 6.


LIBERTY ST.
TEST UNIT 6
CENTRE ST.
SURVEY ROUTE
TOWN BROOK
0
50 m.
.... PORTIONS OF SURVEY ROUTE CORED

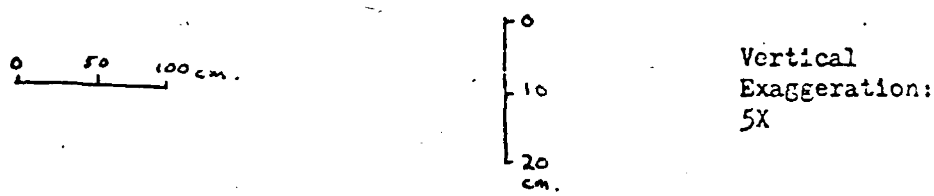
MAP 4. AREA 7.

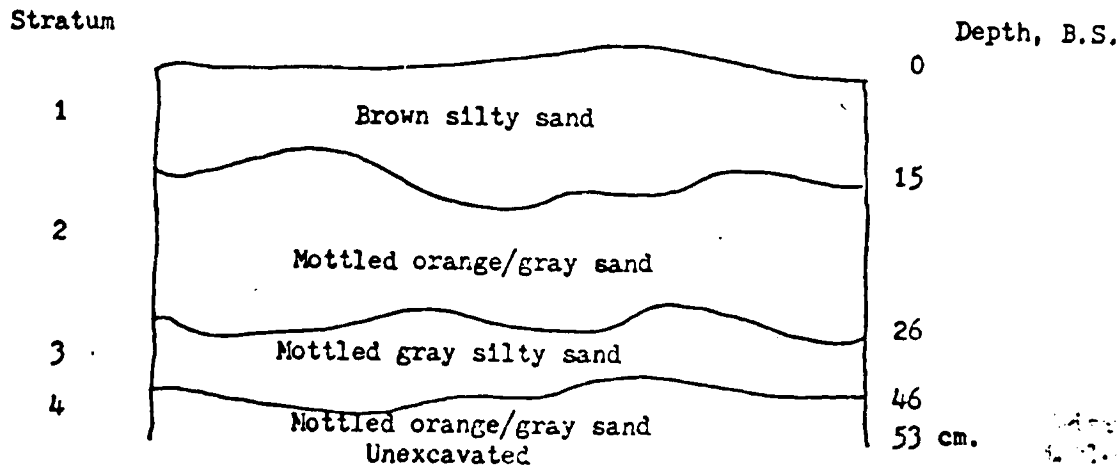


MAP 2. AREAS 1 AND 2.



Profile 1, Test Unit 1, Area 11.





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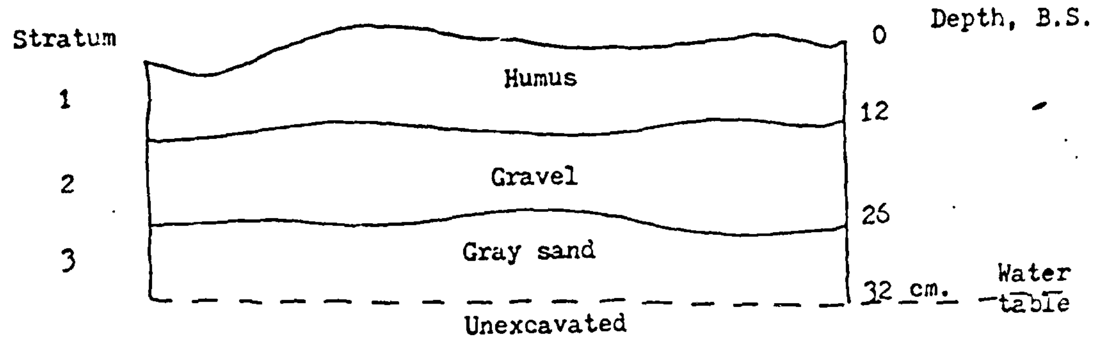

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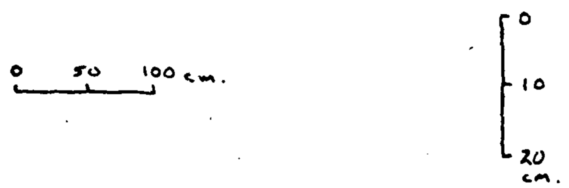
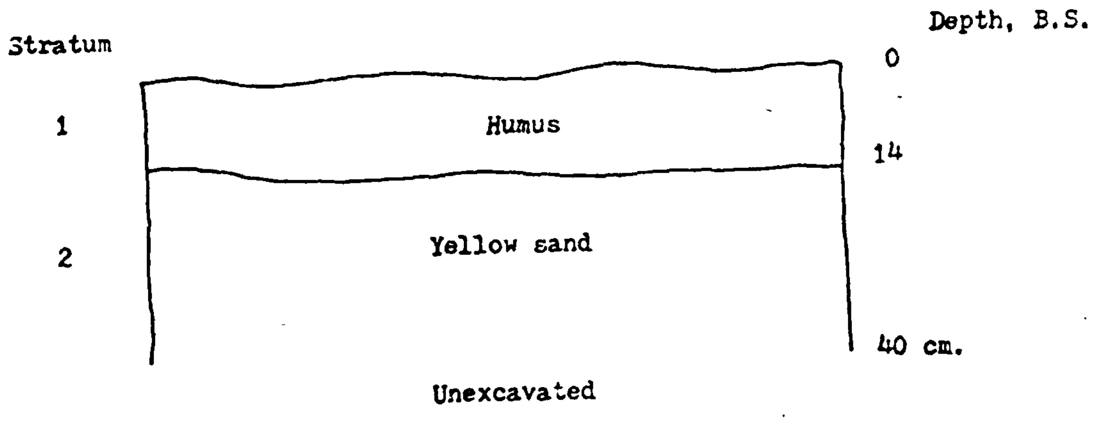
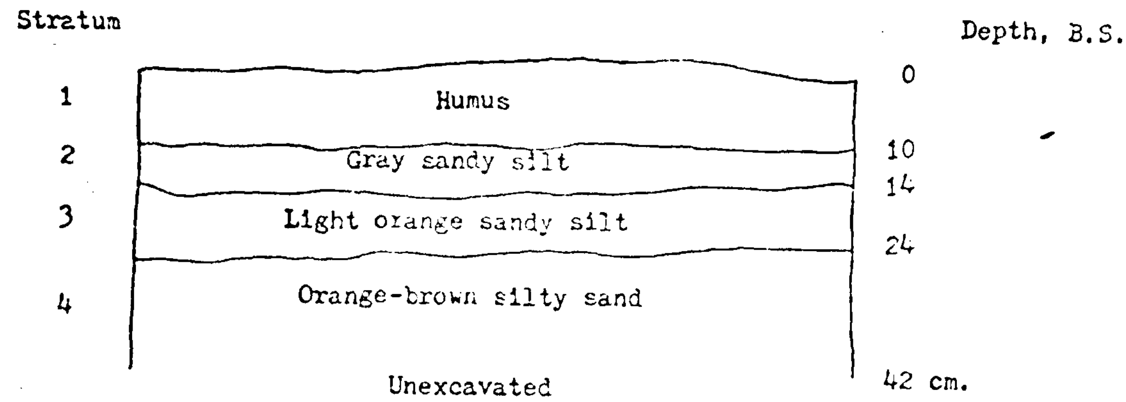


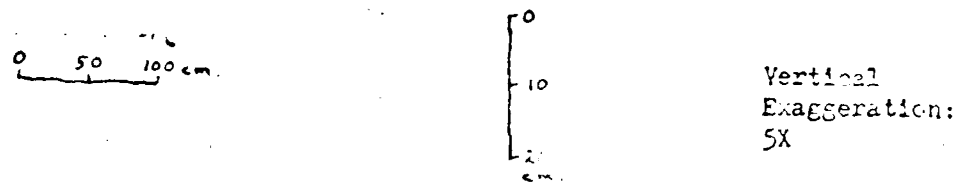
Vertical Exaggeration: 5X

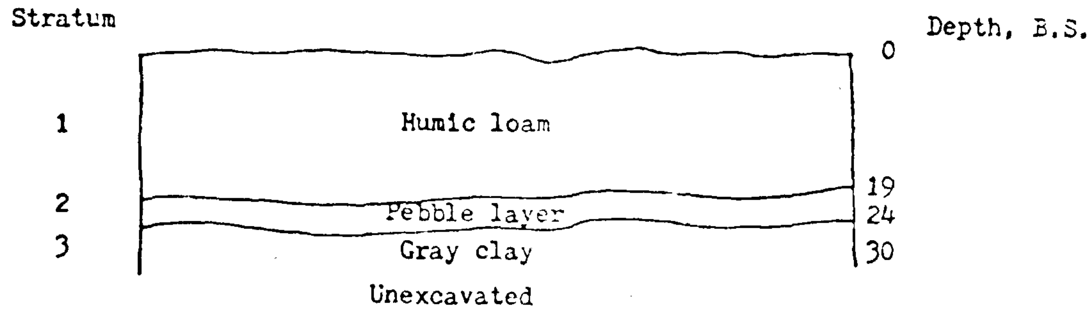


Profile 4, Test Unit 4, Area 1.



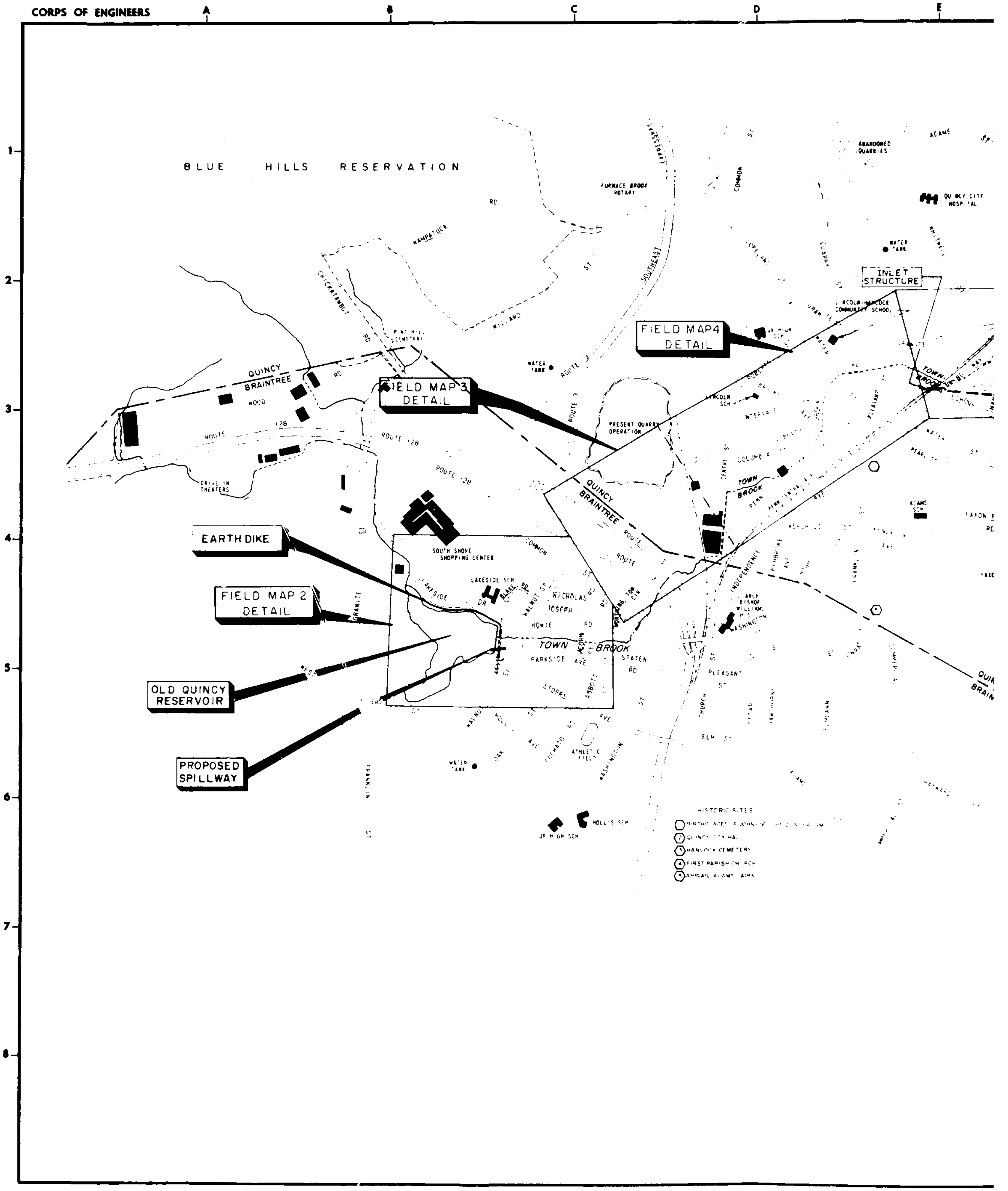
Profile 5, Test Unit 5, Area 6.





Profile 6, Test Unit 6, Area 7.

CORPS OF ENGINEERS



AD-A100 810 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
TOWN BROOK LOCAL PROTECTION, MASSACHUSETTS COASTAL STREAMS: FEA--ETC(U)
SEP 80

UNCLASSIFIED NL

4 of 4
AD A
100 810

END
DATE
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8-81
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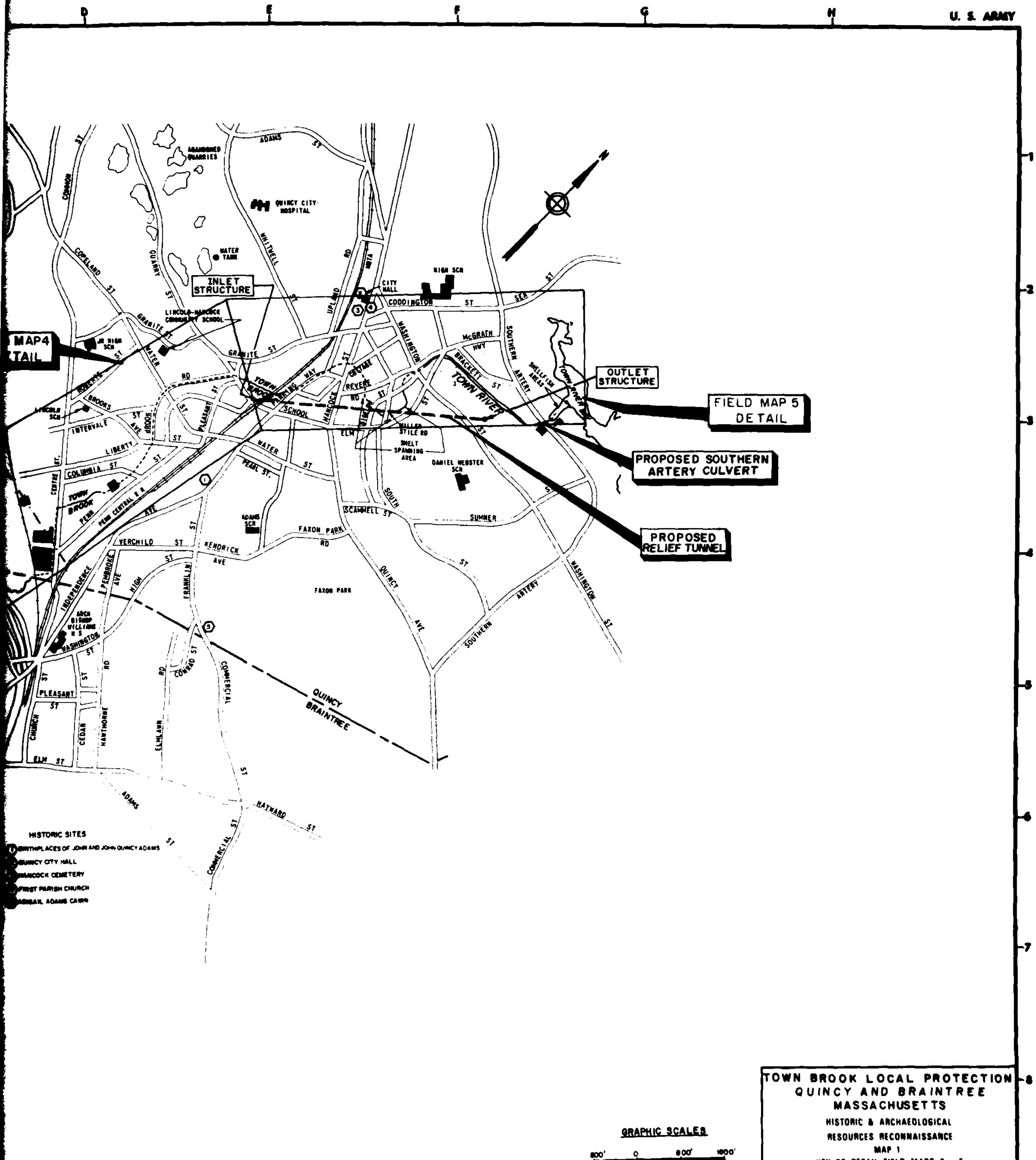
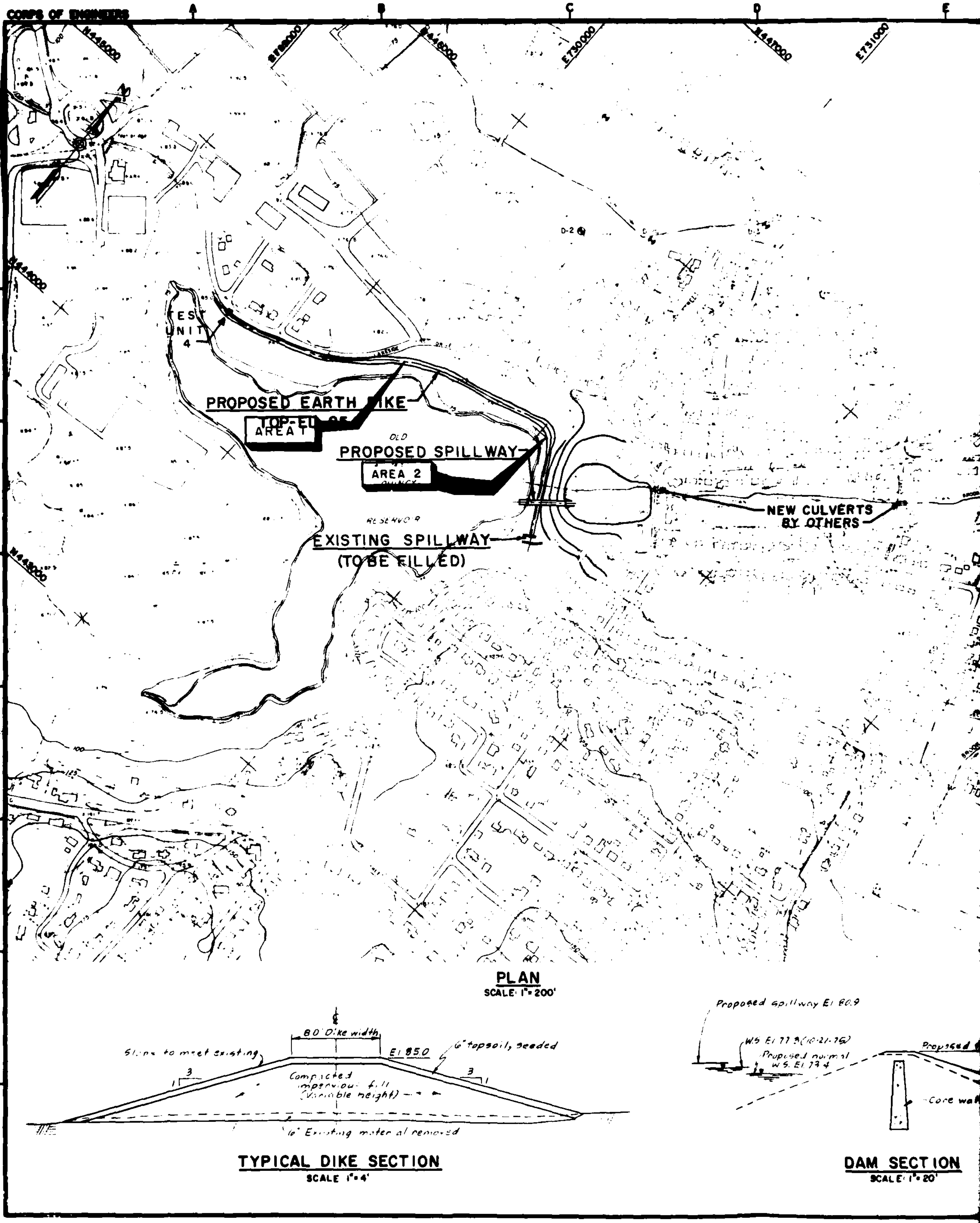
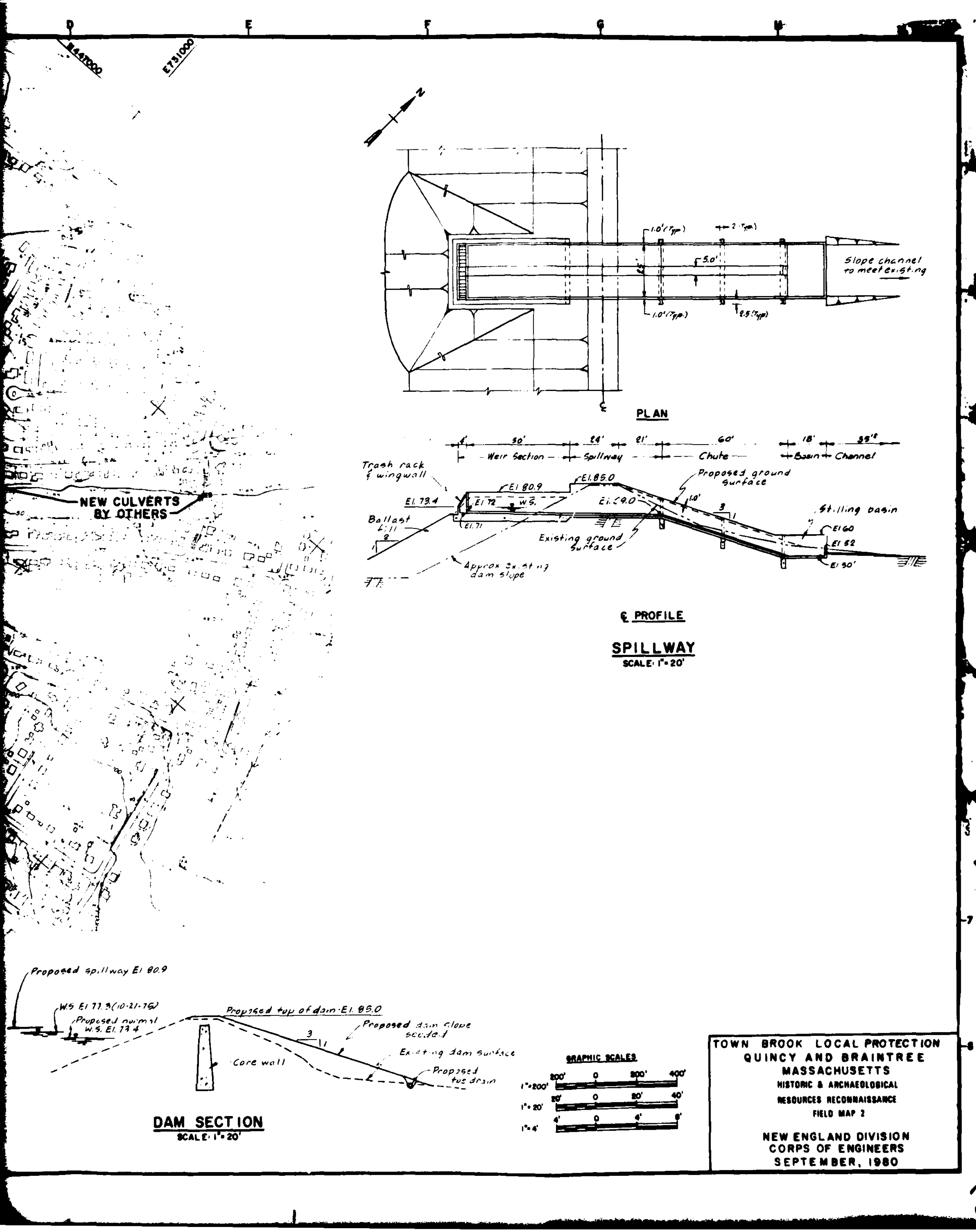


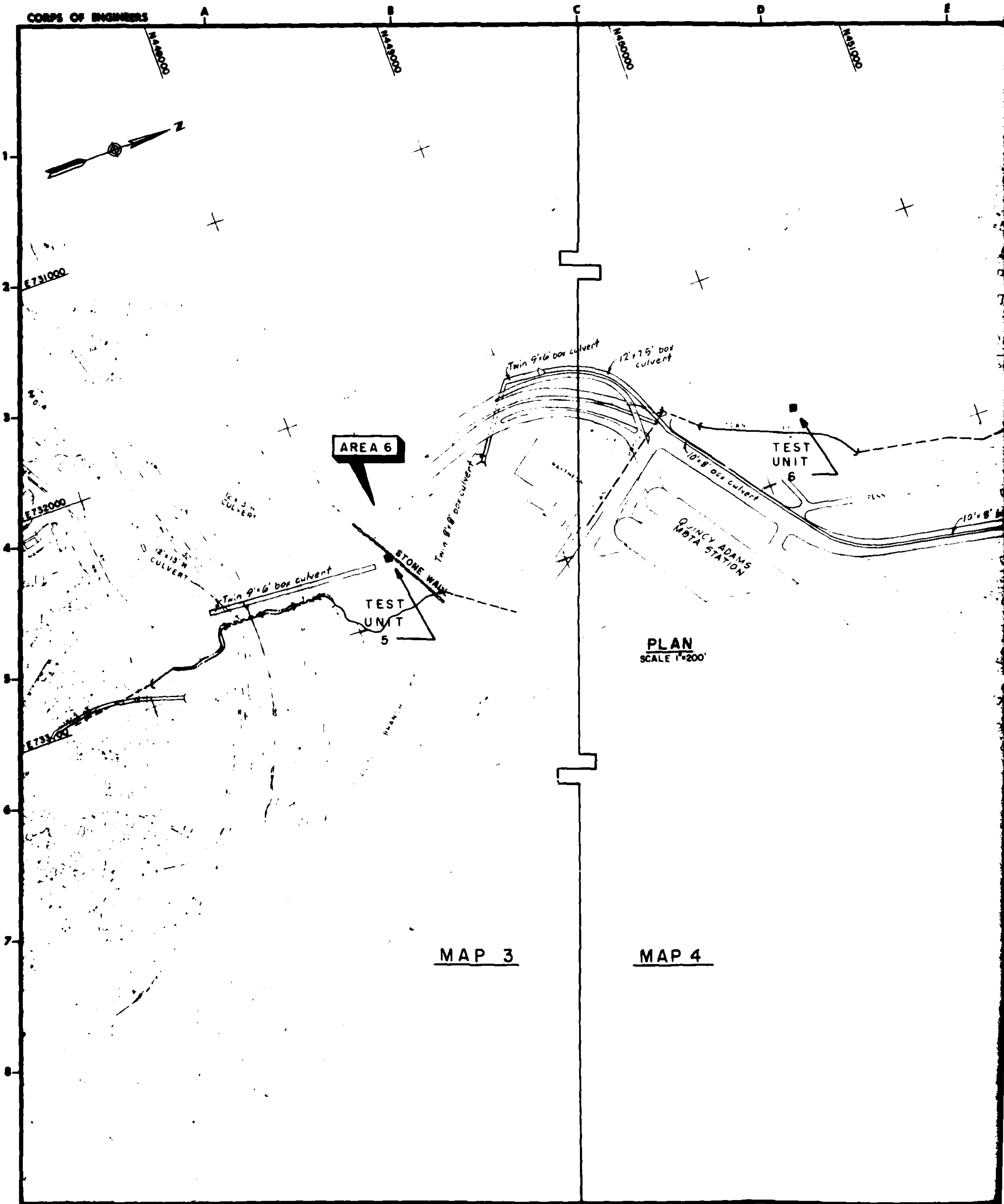
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS
HISTORIC & ARCHAEOLOGICAL
RESOURCES RECONNAISSANCE
MAP 1
KEY TO DETAIL FIELD MAPS 2 5
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

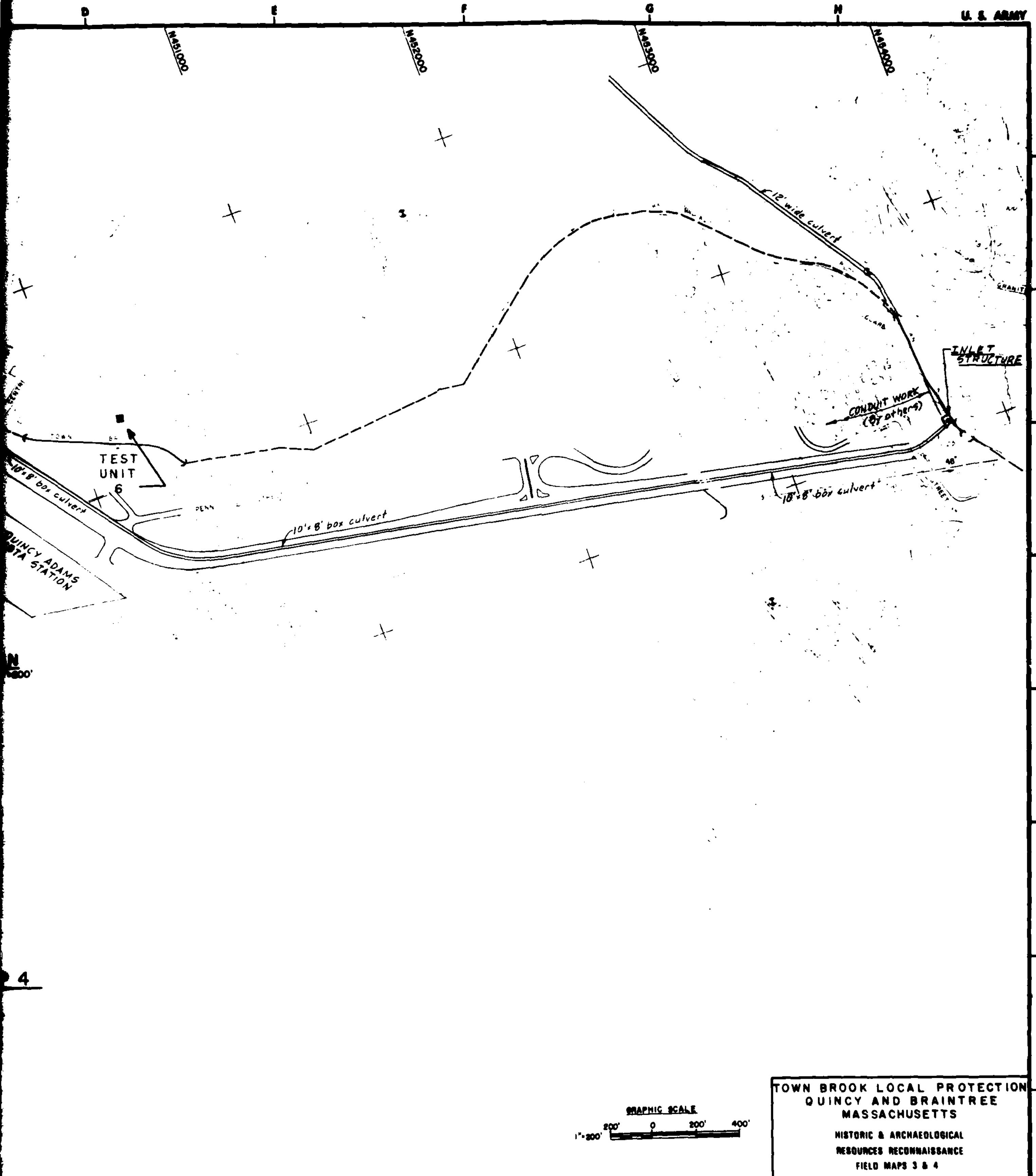


CORPS OF ENGINEERS
A
B
C
D
E
N446000
E729000
N446000
E730000
N447000
E731000
TEST UNIT 4
PROPOSED EARTH DIKE
AREA 1
OLD
PROPOSED SPILLWAY
AREA 2
RESERVOIR
EXISTING SPILLWAY (TO BE FILLED)
NEW CULVERTS BY OTHERS
D-2
PLAN
SCALE: 1"=200'
8.0' Dike width
Slope to meet existing
El 85.0
6" topsoil, seeded
3
1
Compacted impervious fill (Variable height)
6" Existing material removed
TYPICAL DIKE SECTION
SCALE 1"=4'
Proposed spillway El 80.9
Proposed normal W.S. El 79.4
Core wall
DAM SECTION
SCALE 1"=20'

1


NEW CULVERTS
BY OTHERS
PLAN
Slope channel to meet existing
Weir Section
Spillway
Chute
Basin
Channel
Trash rack & wingwall
Ballast
El. 73.4
El 80.9
El 85.0
El 69.0
El 72
W.S.
El 71
Proposed ground surface
Existing ground surface
Approx existing dam slope
Stilling basin
El 60
El 52
El 50'
℄ PROFILE
SPILLWAY
SCALE: 1" = 20'
Proposed spillway El 80.9
W.S. El 77.3 (10-21-76)
Proposed normal W.S. El 73.4
Proposed top of dam El 85.0
Proposed dam slope seeded
Existing dam surface
Core wall
Proposed toe drain
DAM SECTION
SCALE: 1" = 20'
GRAPHIC SCALES
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS
HISTORIC & ARCHAEOLOGICAL
RESOURCES RECONNAISSANCE
FIELD MAP 2
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

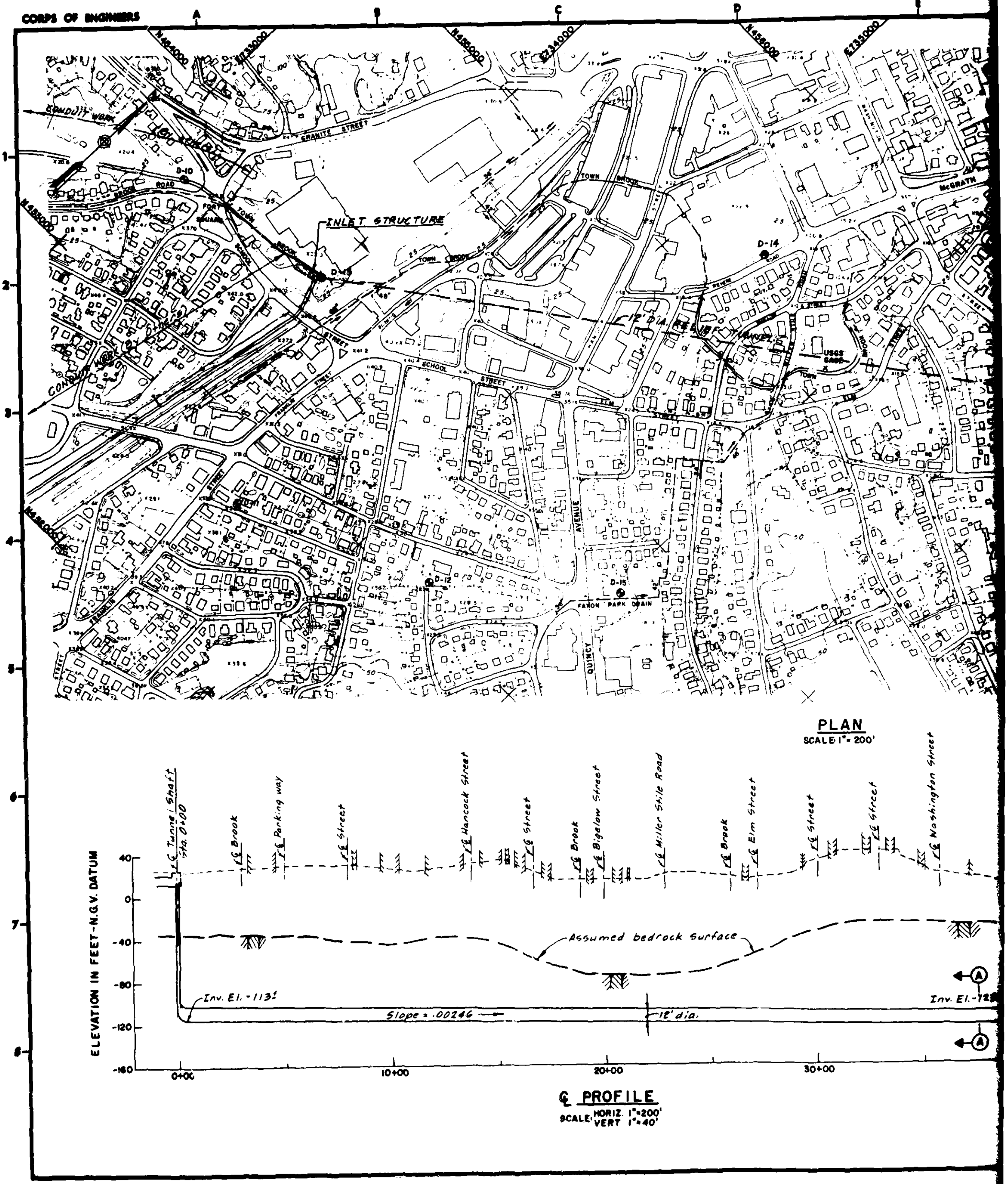

CORPS OF ENGINEERS
A
B
C
D
E
N448000
N449000
N450000
N451000
E731000
E732000
E733000
N
AREA 6
STONE WALL
TEST UNIT 5
TEST UNIT 6
Twin 9'x6' box culvert
12'x7.5' box culvert
Twin 8'x8' box culvert
10'x8' box culvert
12'x13' M CULVERT
QUINCY ADAMS MBTA STATION
PLAN
SCALE 1"=200'
MAP 3
MAP 4



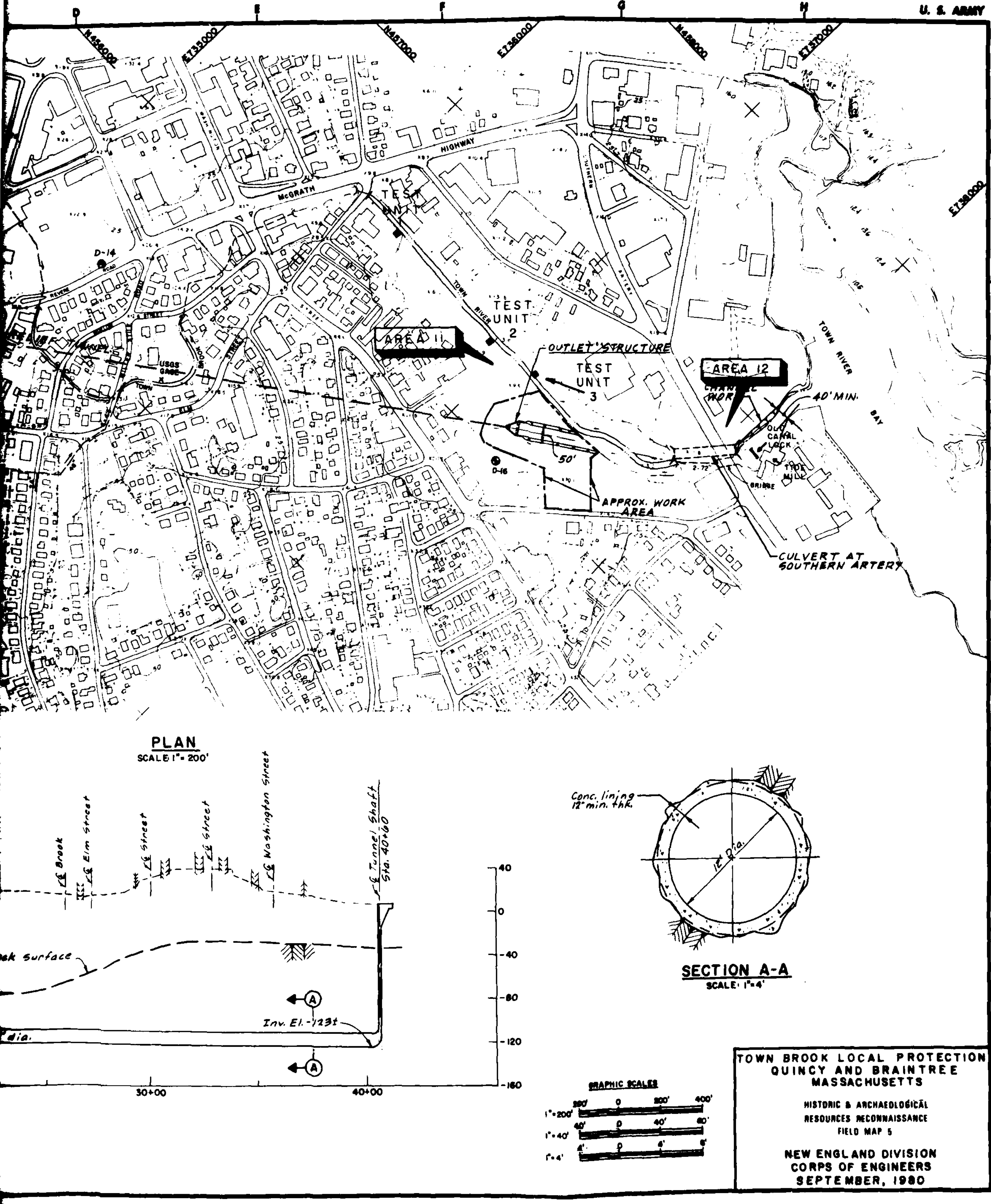
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS

HISTORIC & ARCHAEOLOGICAL
RESOURCES RECONNAISSANCE
FIELD MAPS 3 & 4

NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980



CORPS OF ENGINEERS
A
B
C
D
E
1
2
3
4
5
6
7
8
INLET STRUCTURE
CONDUIT WORK
GRANITE STREET
TOWN BROOK
SCHOOL STREET
FRANKLIN STREET
ELM STREET
McGRATH
12' DIA. RELIEF TUNNEL
USGS GAGE
D-10
D-12
D-14
D-15
FAXON PARK DRAIN
QUINCY AVENUE
N453000
N454000
N455000
N456000
N452000
E733000
E734000
E735000
PLAN
SCALE 1" = 200'
℄ Tunnel Shaft Sta. 0+00
℄ Brook
℄ Parking way
℄ Street
℄ Hancock Street
℄ Street
℄ Brook
℄ Bigelow Street
℄ Miller Stile Road
℄ Brook
℄ Elm Street
℄ Street
℄ Street
℄ Washington Street
Assumed bedrock surface
Inv. El. -113±
Slope = .00246
12' dia.
Inv. El. -12
A
A
ELEVATION IN FEET - N.G.V. DATUM
40
0
-40
-80
-120
-160
0+00
10+00
20+00
30+00
℄ PROFILE
SCALE: HORIZ. 1" = 200'
VERT 1" = 40'



U. S. ARMY
N456000
E735000
N457000
E736000
N458000
E737000
E738000
McGRATH HIGHWAY
TEST UNIT 1
TEST UNIT 2
TEST UNIT 3
AREA 11
AREA 12
OUTLET STRUCTURE
TOWN RIVER
TOWN RIVER BAY
40' MIN.
50'
OLD CANAL LOCK
TIDE MILL
BRIDGE
APPROX. WORK AREA
CULVERT AT SOUTHERN ARTERY
D-14
D-16
USGS GAGE
PLAN
SCALE: 1" = 200'
℄ Brook
℄ Elm Street
℄ Street
℄ Street
℄ Washington Street
℄ Tunnel Shaft Sta. 40+60
Rock Surface
Inv. El. -123±
A
A
30+00
40+00
40
0
-40
-80
-120
-160
Conc. lining 12" min. thk.
12' Dia.
SECTION A-A
SCALE: 1" = 4'
GRAPHIC SCALES
1" = 200'
200' 0 200' 400'
1" = 40'
40' 0 40' 80'
1" = 4'
4' 0 4' 8'
TOWN BROOK LOCAL PROTECTION
QUINCY AND BRAINTREE
MASSACHUSETTS
HISTORIC & ARCHAEOLOGICAL
RESOURCES RECONNAISSANCE
FIELD MAP 5
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
SEPTEMBER, 1980

Appendix I

Economic Studies

APPENDIX I

Economic Studies

Table of Contents

Item	Page
Introduction	I-1
Methodology	I-1
Costs of the Selected Plan	I-2
First Costs	I-2
Annual Costs	I-2
Benefits	I-3
Flood Damage Reduction Benefits	I-3
Future Benefits	I-5
Future Inundation Reduction Due to Growth	I-6
Flood Proofing Costs Saved	I-6
Intensification Benefits	I-7
Location Benefits	I-7
Affluence Benefits	I-8
Employment Benefits	I-11
Discussion of Future Benefits/Development	I-11
Justification	I-12
Internal Rate of Return	I-12
Maximization	I-12
Benefit Analysis of the Nonstructural Plan for 3 Reaches of Town Brook	I-13

List of Tables

No.	Title	Page
I-1	Summary of Estimated First Costs	I-2
I-2	Summary of Estimated Annual Costs	I-3
I-3	Total Annual Benefits by Zone	I-4
I-4	Residual Annual Losses by Zone	I-4
I-5	Total Annual Losses Without Condition	I-4
I-6	Annual Losses and Benefits	I-5
I-7	Projected Levels of Per Capita Income for the Boston SMSA	I-9
I-8	Annual Losses and Benefits to Residual Contents; under Existing Conditions w/o Adjustment for Affluence	I-9
I-9	Annual Losses and Benefits to Residual Contents Contents; with Adjustment for Affluence at 2005	I-10
I-10	Increased Losses and Benefits Due to Affluence	I-10
I-11	Residential Contents Losses	I-10
I-12	Total Discounted Affluence Benefits	I-11
I-13	Summary of Economic Analysis	I-12
I-14	Excess Benefits	I-13
I-15	Benefit/Cost Summary for the Nonstructural Plan	I-16
I-16	Annual Losses and Benefits, Nonstructural Plan	I-17
I-17	Nonstructural Benefit Analysis, Brook Road Pool	I-17
I-18	Nonstructural Benefit Analysis, Shopping Center Pool	I-18
I-19	Nonstructural Benefit Analysis, Bigelow Street Pool	I-19

List of Plates

No.	Title
I-1	Stage-Damage Curve, Brook Road Pool
I-2	Damage Frequency Curve, Brook Road Pool
I-3	Stage-Damage Curve, Shopping Center Pool
I-4	Damage Frequency Curve, Shopping Center Pool
I-5	Stage-Damage Curve, Bigelow Street Pool
I-6	Damage Frequency Curve, Bigelow Street Pool
I-7	Excess Benefits Curve
I-8	Damage Frequency Curve, Affluence Benefits Brook Road Pool
I-9	Damage Frequency Curve, Affluence Benefits Bigelow Street Pool
I-10	Stage-Damage Curve, Brook Road Pool - Additional Structures
I-11	Damage Frequency Curve, Brook Road Pool - Additional Structures
I-12	Stage Damage Curve, Bigelow Street Pool - Additional Structures
I-13	Damage Frequency Curve, Bigelow Street Pool - Additional Structures

Appendix I

Economic Analysis

The purpose of this appendix is to centralize economic material, including both cost and benefit data. Information on the flood plain, the extent of flooding, the recurring and the annual losses is included in Appendix A, Economic and Social Assessment. The material presented in the following pages concerns only those facets of the proposed improvement which can be readily quantified in dollar values.

Methodology

The tangible economic justification of the proposed improvements, which provide essentially complete flood protection against the 100-year flood in the Town Brook flood plain of Quincy, can be ascertained by comparing the equivalent average annual charges (i.e., interest, amortization and operation and maintenance) with an estimate of the equivalent average annual benefits which would be realized over the 100-year period of analysis. The average annual benefits preferably should equal or exceed the annual costs if the Federal Government is to contribute toward the project.

The values given to benefits and costs at their time of accrual are made comparable by conversion to an equivalent time basis using an appropriate interest rate. An interest rate of 7-1/8 percent applicable to public works projects was used in this report. The net effect of converting benefits and costs in this manner is to develop equivalent average annual values.

Because of the high degree of protection afforded and the high quality of maintenance that would be required for flood control works in an established urban area, the physical life of the works would exceed 100 years. Based on these factors, a 100-year period of analysis was selected.

The development of costs and benefits follows standard Corps of Engineers practice. The value of all goods and services used in the project is estimated on the cost side. On the benefit side, damages prevented, future and affluence benefits are estimated. The assessment of damages prevented is based on surveys which provide damage information related to stages or elevations of flooding. This material is then related to frequency data to convert it to average annual values. Annual benefits are then computed by subtracting annual losses expected to occur with the project from those expected without the project in the study area. Graphic development of stage-damage and damage-frequency relationships are shown on the plates at the back of the appendix. Stage frequency curves developed for three index stations are presented in the appendix on hydrology and hydraulics.

Another consideration is maximizing net quantifiable benefits. This is an economic concept aimed at sizing a project or investment to a point where the greatest excess of benefits over costs occurs. In effect, this is the point where the last increment in project size has an incremental cost equal to

incremental benefits, and any further increase in size would not be economically justified. Maximization does not, however, reflect qualitative values. Plate I-7 depicts the results of maximization studies with an Excess Benefits Curve.

Cost of Selected Plan

First Costs

The estimated first costs provide for a relief tunnel and reservoir improvmnet project as described in the report. Quantities of the principla construction items were estimated on the basis of a preliminary design which would provide safe structures for given conditions. The estimates for first costs were based on April 1980 prices. A contigency allowance of 15 percent for above ground construction and 20 percent for underground construction is included. Engineering and design and supervision and projects throughout the Boston area and amount to about 5 percent and 7 percent, respectively.

Table I-1 summarizes the estimated cost of the plan of improvement.

Table I-1 Summary of Estimated First Costs(1)

Relief Tunnel	$15,166,000	
Water Circulation System	552,000	
Relief Tunnel Appurtenant	715,000	
Town River Improvements	1,363,000	
Improvements at Old Quincy Reservoir Dam	574,000	
Total First Construction Cost	$18,370,000	(2)
Engineering and Design	919,000	(3)
Supervision and Administration	1,286,000	
Lands and Damages	175,000	
Total Project First Cost (exclusive of interest during construction period)	$20,750,000	

(1) March 1980 price levels - ENG Const. cost index - 3159

(2) Includes contingencies of 15 percent for above ground construction and 20 percent for below ground construction

(3) Excludes cost of preauthorization studies.

Annual Costs

Estimated annual costs are based on a 100-year period of analysis. Interest during construction is not included since the construction period is estimated as being less than two years. The investment cost thus equals the first cost. Interest and amortization charges are based on an interest rate of 7-1/8 percent. The estimated cost of operation and maintenance is also included. Table I-2 summarizes the annual costs.

Table I-2

SUMMARY OF ESTIMATED ANNUAL COSTS

Item	Cost
Federal	
Interest and Amortization (.07132 x 15,562,000)	1,110,000
Non-Federal	
Interest and Amortization (.07132 x 5,188,000)	370,000
Operation and Maintenance	6,000
TOTAL ANNUAL COST	$1,486,000

Benefits

Benefits which accrue to the selected plan were estimated for the following categories: (1) flood damage reduction, (2) future damages prevented including flood proofing costs saved and (3) affluence benefits. The benefits were estimated in accordance with ER 1105-2-351. An interest rate of 7-1/8 percent, project life of 100 years and April 1980 price level were used.

Flood Damage Reduction Benefits*

Tangible flood damage reduction benefits are determined by taking the difference between annual losses under the without-project conditions and residual annual losses to be anticipated with the selected project. A more detailed discussion of recurring losses and annual losses is included in the economics section of Appendix A. These benefits amount to $1,970,000 and $1,593,000 on an annual basis for the 12' and 8' tunnels respectively. Residual annual losses with the 12' tunnel amount to $92,000 and $469,000 with the 8' tunnel. The distribution of annual losses, benefits and residual losses by geographic location are displayed in Table I-6. Graphic display of the stage-damage and damage frequency relationships for each category and location are displayed in the back of the appendix. The stage-frequency curves prepared by hydrology for each reach are displayed in the hydrology appendix. The three damage zones shown in Table I-3 are defined in the Economics section of Appendix A.

Significant intangible benefits would also ensue from the proposed project. These include a reduction in health hazards caused by polluted floodwaters, a potential improvement in the social and economic well-being of

*All figures are adjusted from August 1979 price level reflected in the Plates to an April 1980 price level.

both residents and economic activities in the area and a cutback in the demand for municipal services (police, fire, public works departments) during flood emergencies. Flooding in the Centre Street Pool is a MDC responsibility. However at frequencies greater than the 100-year event there would be some flood reduction due to the 12' tunnel.

Table I-3 Total Annual Benefits by Zone

	8' Tunnel	12' Tunnel
Brook Road Pool	84,000	199,000
Shopping Center Pool	1,302,000	1,562,000
Bigelow Street Pool	207,000	209,000
TOTAL	1,593,000	1,970,000

Table I-4 Residual Annual Losses by Zone

	8' Tunnel	12' Tunnel
Brook Road Pool	143,000	28,000
Shopping Center Pool	314,000	54,000
Bigelow Street Pool	12,000	10,000
TOTAL	469,000	92,000

Table I-5 Total Annual Losses
(Without Condition)

Brook Road Pool	227,000
Shopping Center Pool	1,616,000
Bigelow Street Pool	219,000
TOTAL	2,062,000

Table I-6 Annual Losses and Benefits

	Natural	Without Condition*	Modified 8' Tunnel	Modified 12' Tunnel
Brook Road Pool				
Annual Losses	143,000	227,000	143,000	28,000
Annual Benefit	-	-	84,000	199,000
Shopping Center Pool				
Annual Losses	290,000	1,616,000	314,000	54,000
Annual Benefit	-	-	1,302,000	1,562,000
Bigelow Street Pool				
Annual Losses	60,000	219,000	12,000	10,000
Annual Benefit			207,000	209,000
TOTAL				
Annual Losses	493,000	2,062,000	469,000	92,000
Annual Benefit			1,593,000	1,970,000

The without condition reflects changed hydrologic conditions due to MDC construction upstream.

Future Benefits

The purpose here is to determine the extent of possible future benefits due to growth and change and to evaluate the practicality of computing such benefits in each of the four benefit categories. These benefit categories are inundation reduction, intensification, location and affluence. They are differentiated as follows:

1. The future inundation reduction benefit is the value of reducing flood losses to activities which will use the flood plain without a project. The benefit consists of the reduction of the amount of future damages and related costs, flood fighting, and required flood proofing costs for example. Future damages are discounted to the base year of the project.

2. The intensification benefit accrues to commercial, industrial and agricultural sectors. The benefit is the value of a plan to activities which, with protection, are enabled to utilize their land more intensively.

3. The location benefit is the value of making the flood plain available for new uses by reducing flood hazards to activities that would use the flood plain only with protection.

4. The affluence benefit accrues based on the assumption that the contents of residential structures will increase in the future. The project affords protection to the increasing contents value.

Field work consisted of inspections and surveys of various sites in Quincy. A map of the flood plain was utilized in conjunction with a zoning map and a land use map. The 1970 Damage Study, updated in 1979, of Town Brook, referenced to the 1968 flood, was employed. All vacant land in the flood plain was noted, zoning for such land was determined and future probable use hypothesized. Land use maps are included in Appendix A. The Quincy Planning Department was consulted about possible zoning changes and present and future demolitions. Citizens with a practical knowledge of the community's affairs were also consulted.

The purpose of the field work was to ascertain which future benefit categories have applicability in the Town Brook flood plain.

The following results in each of the three benefit categories were obtained:

1. Future Inundation Reduction Due to Growth

The only vacant land in the flood plain is 4 acres of land zoned for Residential C development located at Fort Square in the Brook Road Pool. Previous plans by the owners called for the construction of an 8 story, 140 unit apartment complex. Since this structure would be in the flood plain and Quincy is part of the regular FIA program it would be constructed with the first habitable floor above the 100 year flood level. It was assumed this structure would be constructed by 1990. Stage damage and damage frequency relationships were estimated for this structure. Flood damages from damage surveys done for similar structures were employed to estimate stage damage relationships. The stage elevation of the 100-year flood is 3.0 feet above the reference flood and is set as the 1st floor elevation. The annual losses and benefits were estimated and only annual losses and benefits above the 100-year event were considered. The annual losses were negligible, therefore no future inundation reduction benefits were taken.

Flood Proofing Costs Saved

As mentioned above, it is necessary to build the first habitable floor of the new apartment building above the depth of flooding caused by the 100-year event. This is a requirement of the National Flood Insurance Program. Therefore, the building must be flood proofed to a height of four feet above the ground. As an alternative to flood proofing, a parking garage could be built under the building to serve the same purpose. The cost of a parking garage would be similar if not greater than the cost of flood proofing. This estimate was based on one foot of water in the street for the reference flood and the 100-year event at +3.0. With implementation of the selected plan (12' ø tunnel), flood damages at this site will be eliminated as will the requirement for flood proofing the new buildings. The savings in flood proofing costs are as follows: The dimensions of the apartment building is 200 feet long by 80 feet wide. The foundation area is 560 perimeter feet and the four foot increase in foundation height results in an additional 2,240 cubic feet of concrete. Converting to cubic yards equal 83 cubic yards. In addition to

foundation costs, the cost of fill within the foundation walls must be calculated. Length (200') x width (80') x depth (4') equals 64,000 cubic feet or 2,370 cubic yards of additional fill required by flood proofing.

Costs:

Concrete: 83 cu. yds. x $90/cu. yd. in place =	$ 7,470	
Fill: 2,370 cu. yds. x $8/cu. yd. =	18,960	
Total additional costs due to flood proofing =	$26,430	(approx. $26,400)

The cost was then discounted at 12 percent and annualized over the 100-year project life. The cost would have been incurred at the fourth project year under without project conditions and under with project conditions the benefit (cost foregone) would accrue over the final 96 years of project life. The "appropriate" market interest rate chosen was 12 percent. Since the flood proofing costs would be borne by a private sector builder, he would face a cost borrowing reflecting economic conditions and not the government rate. Therefore, a rate approximating the prime rate was employed. Discounting from 1990 to 1986 gives $16,800 and annualizing at 12 percent results in an annual benefit of $2,000 for flood proofing costs foregone.

2. Intensification.

During the field work the area was examined to determine how much industrial and commercial space is currently underutilized.

There is no land in the flood plain being used only partially because of a flooding problem. All of the land in the flood plain is being used to its maximum potential. There could be negligible amounts of space in cellars not being used due to the frequent low level flooding and seepage which occurs. The economic impact of the potential lost space would be insignificant and therefore was not quantified.

3. Location

This third type of benefit results from making the flooo plain available to those who would locate there only with a land use plan. In Quincy, flooding does not appear to be a factor in site preference. Businesses are currently locating in its flood plain and plans are being developed for urban renewal. The new businesses would have damages comparable to those occupying the properties at the time of the 1978 study. Businesses currently locating in Quincy are moving into existing structures. This is due to the lack of land in the flood plain available for growth. Activities moving into the flood plain merely occupy vacated structures replacing other activities.

Affluence Benefits*

Affluence benefits are based on the assumption that the contents of residential structures will increase in value as the income of the dwellers of these residential units increase. The affluence factor methodology, outlined in ER 1105-2-351 was adhered to in the estimation of this benefit. Residential land use accounts for 35 percent of total acreage in Quincy. When vacant land and the MDC Reservation are subtracted, the share of residential land use rises to approximately 60 percent. The area of roughly 175 acres subject to flooding when Town Brook overflows its banks contains 205 residential structures which range from low to middle income in nature. These residences are located in the Brook Road Pool and the Bigelow Street Pool with only one apartment building in the Shopping Center Pool. For the city of Quincy as a whole single family homes comprise approximately one-half of the total residential structures, with 2 family houses accounting for 28 percent, 3 and 4 family structures making up 16 percent and 5+ family units being the remainder. The value of these homes vary with size, however consultations with real estate personnel, the City Assessor and examination of recent sales place average value in the high 20 thousand to mid 30 thousand range. The city of Quincy currently operates under the regular phase of the Flood Insurance Program (FEMA).

A reoccurrence of the 1968 storm under present development conditions in Quincy would result in approximately $321,000 in recurring residential damages, or 32 percent of total recurring damages. Overall, the appearance of the residential area is good with the majority of the homes well maintained and tidy streets.

110 homes were selected to be taken for the accrual of affluence benefits with implementation of the selected plan. The homes were selected on the basis of appearance, condition, maintenance and the non-transient nature of the occupants. Interviews taken during the flood damage survey (1970) and update (1979) indicate that the value of household contents averaged 40 percent of the value of the structure. Employing the affluence factor methodology, the value of residential contents was increased to 75 percent of the structural value and limited to the first 50 years of project life. Thus the additional increment due to future content value based on affluence would be 87.5 percent. This figure is arrived at by dividing future maximum content value percentage by present content value percentage, .75/.40 = 1.875.

The numbers of years that it would take for contents to grow to the maximum 75 percent was calculated using the OBERS regional growth factor for per capita income. Data from OBERS projections for the Boston SMSA were used to calculate the growth period as follows:

*Price levels are not updated in this section except for the final benefit figure.

Table I-7
Projected Levels of Per Capita Income for the Boston SMSA Source: OBERS, Series E

Year	Per Capita Income	10 Year Increase (%)	Annual Compound Growth Rate for Each 10 Year Period
1970	$ 4,050		
1980	5,500	.3580	.03125
1990	7,000	.2727	.02437
2000	9,200	.3142	.0275
2020	14,500	.5760	.023125

The increase in per capita income over the 50 year period is projected to be 358 percent with an annual compound growth rate of 2.5 percent for the same period.

Employing compound interest tables at an annual growth rate of 2.56 percent or (2 9/16) percent and an affluence factor of .875 it will take 25 years for the contents value to grow to 75 percent of the structural value of a residence.

Stage damage curves were then prepared for the residential contents losses for each zone. Of the 110 structures for which affluence benefits are expected to accrue, 75 are located in Brook Road Pool and the remaining 35 in Bigelow Pool. A repeat of the flood of record (1968) would result in contents losses of $107,000 in Brook Road Pool and $34,000 in Bigelow Street Pool. Physical loss data was combined with hydrologic stage-frequency data for each zone to produce annual residential content losses, benefits to the 12' tunnel and 8' tunnel and residual losses. Forty percent of these values was taken as the value for annual losses and benefits to contents. The following tables display annual damages to residential contents both "with" and "without" the project and under existing conditions and after adjustment for affluence.

Table I-8
Annual Losses and Benefits to Residential Contents; under Existing Conditions Without Adjustment for Affluence

Zone	Annual Losses w/o Project Natural	Annual Losses Upstream Imp No Tunnel	Annual Losses 8' Tunnel	Annual Losses 12" Tunnel	Benefits to Project 8'	Benefits to Project 12'
Brook Road Pool	29,600	43,800	29,600	7,400	14,200	36,400
Bigelow Pool	900	3,400	200	100	3,200	3,300
	30,500	47,200	29,800	7,500	17,480	39,700

Since it takes 25 years for contents value to reach 75 percent of structural value and it is estimated that it will take 6 years to project completion, affluence growth reaches the maximum 75 percent level during the 19th year of project life (2005).

Table I-9
Annual Losses and Benefits to Residential Contents; with Adjustment for Affluence at 2005 (no discounting)

Zone	Annual Losses Natural	Annual Losses No Tunnel	Losses 8' Tunnel	Losses 12' Tunnel	Benefits 8' Tunnel	Benefits 12' Tunnel
Brook Road Pool	55,500	82,100	55,500	13,900	26,600	68,200
Bigelow Pool	1,700	6,400	400	190	6,000	6,210
	57,200	88,500	55,900	14,090	32,600	74,410

The increase in annual losses and benefits due to the application of the affluence factor in each zone is exhibitied in the following table:

Table I-10
Increased Losses and Benefits Due to Affluence

Zone	Annual Losses Natural	Annual Losses No Tunnel	Annual Losses 8' Tunnel	Annual Losses 12' Tunnel	Annual Benefits 8' Tunnel	Annual Benefits 12' Tunnel
Brook Road Pool	$25,900	$38,300	$25,900	$6,500	$12,400	$31,800
Bigelow Street Pool	800	3,000	200	90	2,800	2,910
Total	$26,700	$41,300	$26,100	$6,590	$15,200	$34,710

Table I-11
Residential Content Losses

Residential Contents Losses: (12' Tunnel)

	1980	1986	1996	2005
W/o Selected Plan	47,200	57,100	69,430	75,170
With 12' Tunnel Selected Plan	7,500	9,085	11,060	11,980
Benefits	39,700	48,015	58,370	63,190

Residential Contents Losses: (8' Tunnel)

	1980	1986	1996	2005
W/o Selected Plan	47,200	57,100	69,430	75,170
With 8' Tunnel Selected Plan	29,750	36,025	43,850	47,480
Benefits	17,400	21,075	25,580	27,690

Table I-12

Total Discounted Affluence Benefits are:

		8' Tunnel	12' Tunnel
1980 to 1986	=	$ 3,675	$ 8,315
1986 to 1996	=	$ 4,505	$10,355
1996 to 2005	=	$ 2,110	$ 4,820
	Total:	$10,290	$23,490
April 1980 Price Level		$10,700	$24,430
Approx.		$11,000	$24,000

Employment Benefits

Employment benefits represent the value of local labor that would be used on the project and which without the project would be unemployed or underemployed. Employment benefits may only be taken for an area which has persistent and substantial unemployment, as cited in the Federal Register on 14 December 1979. Quincy does not qualify under these regulations and no employment benefits were taken.

Discussion of Future Benefits/Development

In conclusion, major future benefits from economic growth are limited by the lack of vacant and buildable land, and large-scale residential growth in the flood plain is not expected. The intensification benefit is virtually nil in the Town Brook flood plain. The future benefits are negligible. One percent of the benefits to the 8' tunnel and to the 12' tunnel were future benefits.

Economic activities do not consider possible flooding as a factor in locating in the flood plain of Town Brook. There are businesses locating in vacated structures at the present time. The Gilchrist Building has just been rehabilitated (approx. $750,000), and the new occupants are economically comparable to the previous occupants.

Quincy is in the process of planning and initiating construction upon the downtown business district. This is discussed in detail under the future without condition in Appendix A. It was determined that future benefits would not be estimated for the urban development planned for the Shopping Center Pool. The planned development will replace similar existing activities in the flood plain. Attempting to estimate these future losses would introduce a high level of uncertainty into the analysis. It was felt that the level of effort required for such an analysis was unnecessary given the present level of benefits. The planned downtown development in Quincy is seen as assurance that annual benefits would not decrease at some point in the future. As the planned urban development occurs annual benefits may increase significantly as the local economy grows.

Table I-13
Summary of Economic Analysis

Category	8'	12'	15'*
I. Flood Damage Reduction	1,593,000	1,970,000	2,062,000
II. Future Flood Proofing Costs Saved	2,000	2,000	2,000
III. Affluence Benefit	11,000	24,000	29,000
TOTAL	1,606,000	1,996,000	2,093,000
Average Annual Cost	1,115,000	1,486,000	1,976,000
Benefit-to-Cost Ratio	1.44	1.34	1.06
Net Remaining Benefits	491,000	510,000	117,000

*The approach used for the 15' tunnel was as follows: the maximum benefits possible (natural losses) were assigned to the 15' tunnel to test the possibility that the maximum net remaining benefits would occur at the 15' tunnel.

Justification

The estimated annual costs, annual benefits and the ratio of benefits to costs are summarized in Table I-12, Summary of Economic Analysis. This analysis indicates that the three tunnel options analyzed for the Town Brook flood protection project are economically justified.

Internal Rate of Return

In accordance with ER 1105-2-351, a specific check is included showing the rate of interest at which benefits equal costs over the period of analysis (i.e., the benefit-cost ratio equals 1.0). The Federal interest rate used was 7-1/8 with the project life being 100 years. The relationship of first cost x capital recovery factor = annual cost was used to find the internal rate of return.

	8' Tunnel	12' Tunnel	15' Tunnel
First Cost ($1,000) =	$15,560	$20,750	$27,600
Annual Costs ($1,000) =	1,115	1,486	1,976
Annual Benefits ($1,000) =	1,606	1,996	2,093
Benefit - to - Cost Ratio =	1.44	1.34	1.06
Internal Rate of Return =	10-3/8	9-5/8	7-1/2

Maximization

Maximizing net tangible benefits is an economic concept utilized to size a project or investment to the point where the greatest excess benefits over costs occurs. Several different tunnel sizes were considered for the Town Brook Project and the analysis is shown on Table I-14 and on Plate I-17. It was determined that the maximum net benefits occur with a 10.7' diameter tunnel.

Table I-14

Excess Benefits

Tunnel	Annual Cost	Annual Benefits	Excess Benefits
8'	1,115,000	1,606,000	491,000
12'	1,486,000	1,996,000	510,000
15'	1,976,000	2,093,000	117,000

Benefit Analysis of the Nonstructural Plan for 3 Reaches of Town Brook

The following section presents the economic analysis of the proposed nonstructural flood proofing plan for 3 reaches of Town Brook, Quincy. A detailed presentation of the engineering and costs is presented in Appendix F. There are 3 major types of flood protection provided in this plan: floodwalls (ringwalls) which completely encircle a structure or group of structures and provide complete protection up to the designed level; utility cells which prevent physical losses to the utilities in the basement of a structure; and flood proofing the foundation of a structure which gives complete protection up to the designed level.

The benefits for the nonstructural plan were estimated based upon flood damage reduction provided to the 100 year level of flooding. Losses were analyzed using a computer program, Interactive Nonstructural Analysis. In many cases annual losses were computed for individual structures, but whenever possible the losses for a number of structures would be aggregated and a single annual loss figure would be estimated.

A comparison of annual losses up to the 100 year event between the structural and nonstructural plan will show lower annual loses for the nonstructural plan. The economic analysis of the nonstructural plan estimated annual losses only for those losses preventable under the nonstructural plan. Properties protected by the utility cells would continue to suffer the same nonphysical losses. Physical losses would be eliminated up to the 100 year level for the utilities but all other physical losses would continue. The annual losses were based upon only those losses prevented by the utility cells. For the ringwalls in the Brook Road Pool all losses were preventable and there are no differences in annual losses up to the 100 year level between the structural plan and the nonstructural plan.

Commercial structures were evaluated on an individual basis to determine if nonphysical losses would be prevented by the proposed nonstructural measures. In those cases where the commercial activity is shut down for a long period of time as a consequence of the damage caused by

flooding the nonphysical losses will be taken as a benefit. The other major cause of nonphysical losses is the closure of commercial activities due to the presence of floodwaters in the streets. When it was determined that this was the case, the nonphysical losses would not be prevented by the nonstructural plan.

The Brook Road Pool experiences flood damages to both residential and commercial properties. The residential properties number 69 and are protected by ringwalls (33 structures) or by utility cells. With the structural plan there were 95 structures but 26 of these structures were not included in the nonstructural plan. It was determined that these 26 structures suffered minimal losses which would not be prevented by the proposed nonstructural methods. The ringwalls are credited with providing complete protection up to the 100 year level while the utility cells provide 100 year level protection only to a small portion of the experienced losses. There are 10 commercial structures in this pool of which 8 receive complete 100 year level protection.

The Shopping Center Pool has only commercial activities in the nonstructural plan. There are 11 structures which contrasts with the 60 structures evaluated in the structural plan for this zone. This discrepancy results from the different manner of considering what is a structure. The nonstructural plan emphasizes the physical structure of the building which can be protected as a unit while the structural plan bases losses upon the separate establishments.

The losses in the Shopping Center Pool were grouped into four units for the economic analysis. In the engineering analysis for the nonstructural plan there were considered to be 6 buildings on Parking Way Road. The costs for the nonstructural flood control methods for those 6 structures were grouped into one cost and this was compared with the losses experienced by all the establishments on Parking Way Road. Similarly the engineering analysis for nonstructural plan considered there were 3 structures on Hancock Street. The costs for these 3 structures were grouped together and compared with the losses for all establishments on Hancock Street.

In both of the above cases only physical losses presented were considered as benefits. Two structures coincided with separate establishments and offered 100 year protection against both physical and nonphysical losses. The one residential structure in the Shopping Center Pool was an apartment building which was not protected in the nonstructural plan.

In the Bigelow Street Pool all of the residential structures were protected by utility cells. Benefits were received only for the prevention of physical losses to the utilities. The majority of the losses in this pool were from the 5 commercial/industrial structures. Three of these structures received complete protection to the 100 year level.

In the Bigelow Street Pool and the Brook Road Pool the residual losses were low. This is explained by the fact that most losses occur to the commercial/industrial structures which receive complete 100 year pro-

tection. The residual losses for the Brook Road Pool are 29 percent of the total losses for that reach and for the Bigelow Street Pool the residual losses are 10 percent.

Justification

The benefit-cost ratio varies among the individual structures from .002 to 20.5 as can be seen in Tables I-17 to I-19. The economic analysis for the nonstructural plan is summarized in Table I-15. The BCR for the entire nonstructural plan is 1.8 and excess benefits are $178,500. Residual losses are very high for the nonstructural plan, as indicated in Table I-16, they amount to approximately $1.7 million or 81 percent of the total annual losses.

Table I-15

Benefit-Cost Summary for the Nonstructural Plan

	Commercial				Residential				Total			
	# of Structures	$1000 Cost	$1000 Benefit	BCR	# of Structures	$1000 Cost	$1000 Benefit	BCR	# of Structures	$1000 Cost	$1000 Benefits	BCR
Brook Road Pool	10	307.9			69	957.4			79	1,265.3		
Annual Cost/Benefit		22.0	30.0	1.36		68.3	104.0	1.52		90.3	134.0	1.48
Bigelow Street Pool	5	191.1			25	222.5			30	413.6		
Annual Cost/Benefit		13.6	117.0	8.53		15.9	1.0	.07		29.5	118.0	3.97
Shopping Center Pool	11	472.2							11	472.2		
Annual Cost/Benefit		33.7	147.0	4.36						33.7	147.0	4.36
First Cost	26	971.2			94	1,179.9			120	2,151.1		
Annual Cost										153.5		
First Cost: Floodwarning										25.0		
Annual Cost: Floodwarning										2.0		
Operations & Maintenance		25.0				40.0				65.0		
Total Annual Cost/Benefit		94.3	294.0	3.1		124.2	105.0	.85		220.5	399.0	1.8

Excess Benefits 178.5

Table I-16 Annual Losses and Benefits, Nonstructural Plan

	Total Annual Losses (without condition)	100 Year Losses Benefits to Nonstructural Plan (% of total)	Residual Losses
Brook Road Pool	227,000	134,000 (59%)	93,000
Shopping Center Pool	1,616,000	147,000 (9%)	1,469,000
Bigelow Street Pool	219,000	118,000 (54%)	101,000
TOTAL	2,062,000	399,000 (19%)	1,663,000

Table I-17 Nonstructural Economic Analysis Brook Road Pool

Title	Benefits	First Cost	Annual Cost	BCR
Residential				
Ringwall A17	42,688	282,200	20,100	2.12
Ringwall B16	43,939	265,600	18,950	2.31
Total Alt 128	17,776	409,200	29,200	.61
Total Residential	104,403	957,000	68,250	1.53
Commercial				
Property #1	7,566	79,000	5,600	1.35
Property #2	222	4,700	340	.65
Property #3	16	13,700	980	.02
Property #4	194	14,200	1,000	.19
Property #5	340	13,400	950	.36
Property #6	285	5,600	400	.71
Property #7	28	3,400	240	.12
Property #8	1,964	8,200	600	3.27
Property #9	17,318	126,400	9,000	1.92
Property #10	1,926	39,300	2,800	.69
Total Commercial	29,859	307,900	21,910	1.36
Total Commercial Residential	134,262	1,264,900	90,160	1.49

Table I-18 Nonstructural Economic Analysis
Shopping Center Pool

Commercial

Title	Benefits	First Cost	Annual Cost	BCR
Parkingway 6BLD	67,566	244,000	17,400	3.88
Property #11	2,266	3,000	200	11.3
Property #12	19,811	103,200	7,400	2.67
Hancock 3 BLD	57,740	122,000	8,700	6.64
Total Commercial	147,383	472,200	33,700	4.36

Table I `9 Nonstructural Economic Analysis
Bigelow Street Pool

Residential

Title	Benefits	First Cost	Annual Cost	BCR
Property #13	152	12,200	870	.17
Property #14	3	4,700	340	.008
Property #15	24	4,700	340	.07
Property #16	2	4,700	340	.005
Property #17	28	12,200	870	.03
Property #18	150	12,200	870	.17
Property #19	23	12,200	870	.02
Property #20	23	12,200	870	.02
Property #21	2	4,700	340	.005
Property #22	150	12,200	870	.17
Property #23	37	12,200	870	.04
Property #24	3	12,200	870	.003
Property #25	14	4,700	340	.04
Property #26	20	4,700	340	.05
Property #27	2	4,700	340	.002
Property #28	24	12,200	870	.02
Property #29	3	12,200	870	.003
Property #30	105	12,200	870	.11
Property #31	105	12,200	870	.11
Property #32	105	12,200	870	.11
Property #33	14	12,200	870	.01
Property #34	24	4,700	340	.07
Property #35	91	4,700	340	.26
Property #36	2	4,700	340	.005
Property #37	23	4,700	340	.06
Total Bigelow Residential	1,129	222,500	15,820	.07

Commercial

Property #38	3,548	36,400	2,600	1.36
Property #39	109,817	75,000	5,350	20.5
Property #40	247	4,700	340	.73
Property #41	668	39,900	2,800	.24
Property #42	2,327	35,100	2,500	.93
Total Commercial	116,607	191,100	13,590	8.6
Total Residential/ Commercial	117,736	423,000	30,090	3.9

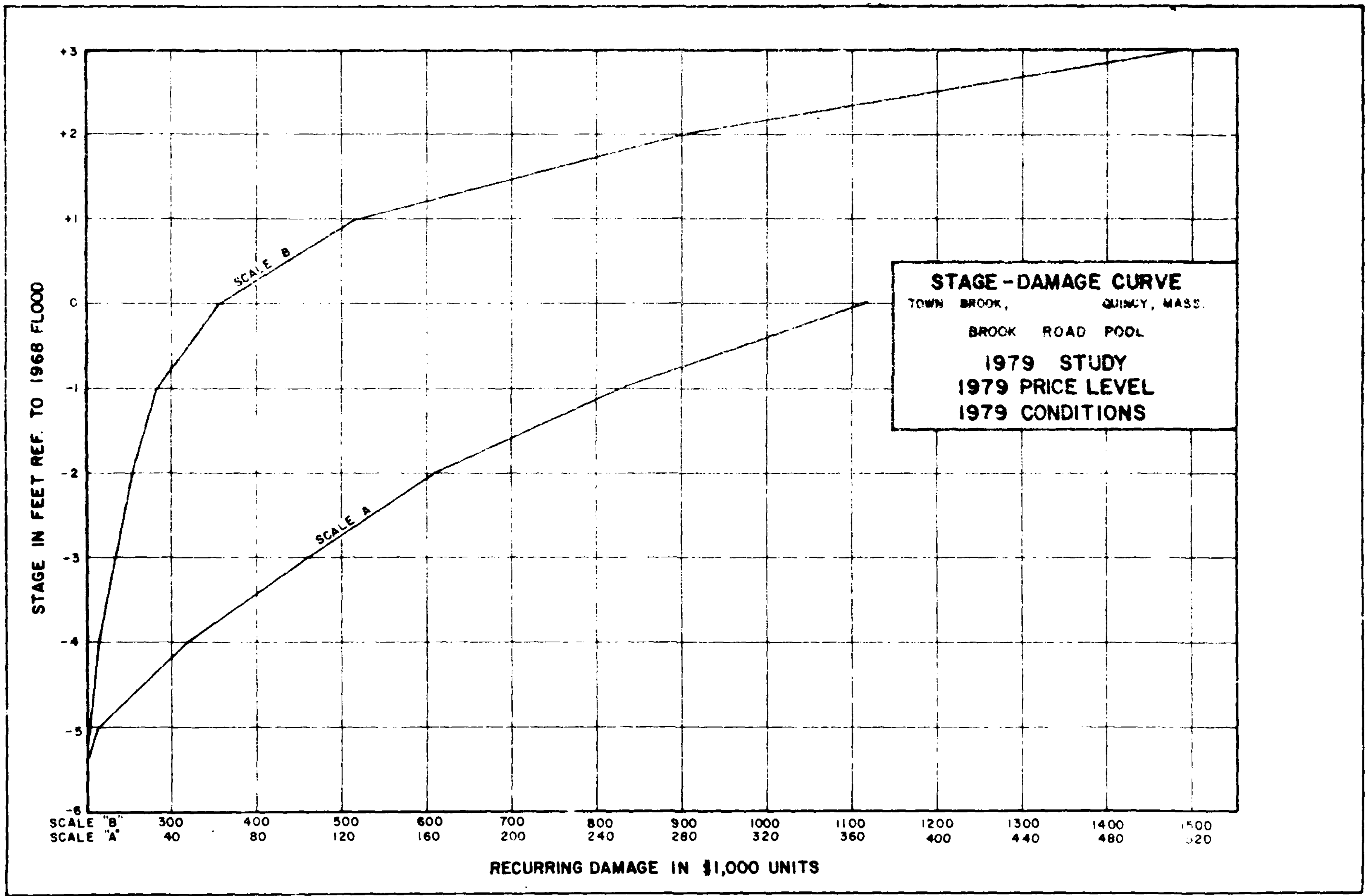
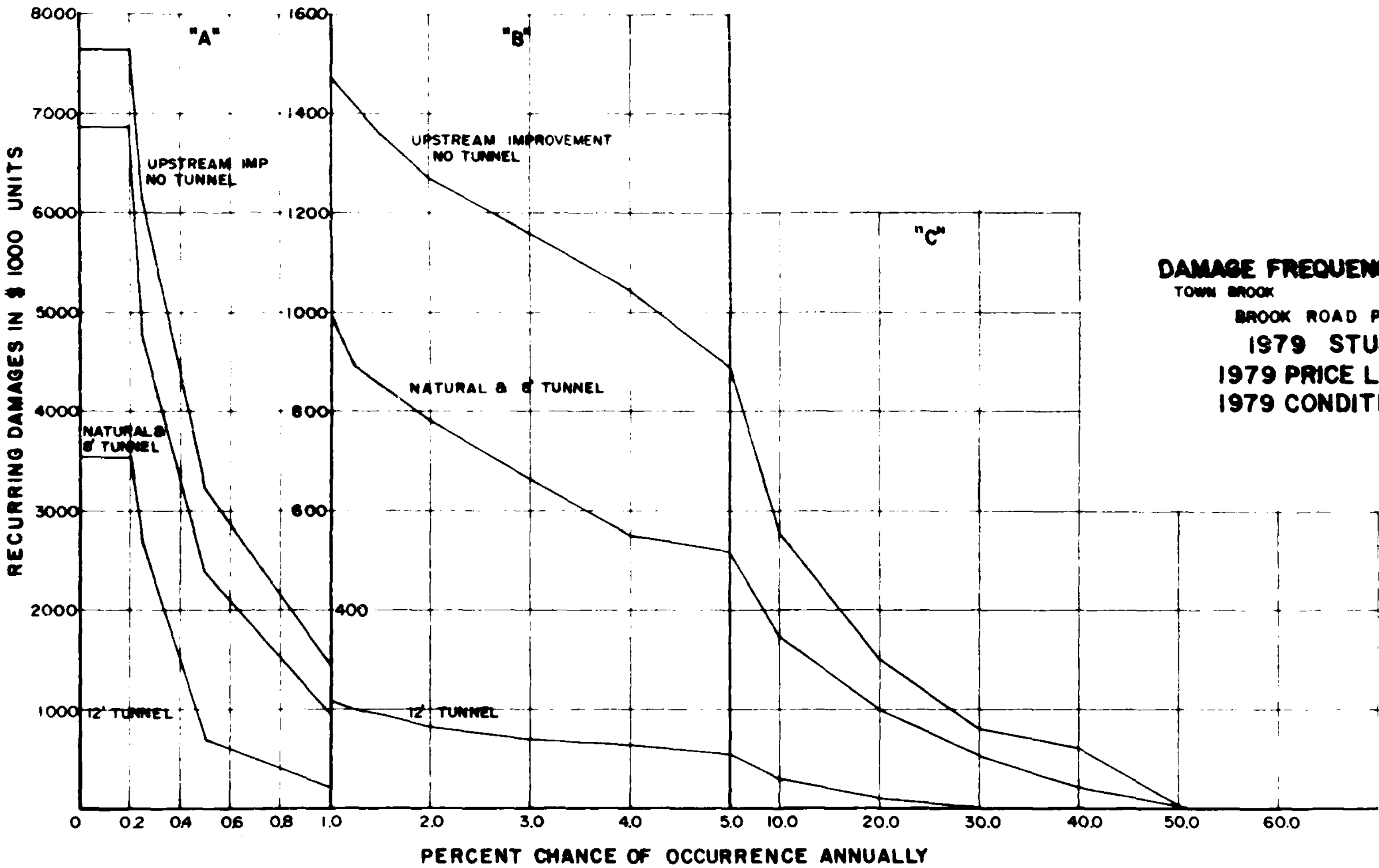

STAGE - DAMAGE CURVE
TOWN BROOK, QUINCY, MASS.
BROOK ROAD POOL
1979 STUDY
1979 PRICE LEVEL
1979 CONDITIONS
SCALE B
SCALE A
STAGE IN FEET REF. TO 1968 FLOOD
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
SCALE "B"
SCALE "A"
300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
40 80 120 160 200 240 280 320 360 400 440 480 520
RECURRING DAMAGE IN $1,000 UNITS

PLATE I-1

	RANGE "A" 1 SQ IN = $4000			RANGE "B" 1 SQ IN = $2000			RANGE "C" 1 SQ IN = $20,000			TOTAL	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSSES	BENEFITS
NATURAL + 8' TUNNEL	7.8	31,200	8400	13.6	27,200	19,000	3.6	72,000	48,000	130,400	75,400
UPSTREAM IMP NO TUNNEL	9.9	39,600	-8400	23.1	46,200	-15000	6.0	120,000	-48000	205,800	75,400
12' TUNNEL	3.4	13600	28000	2.5	5000	41,200	.3	6000	114000	24,600	181,200



DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS

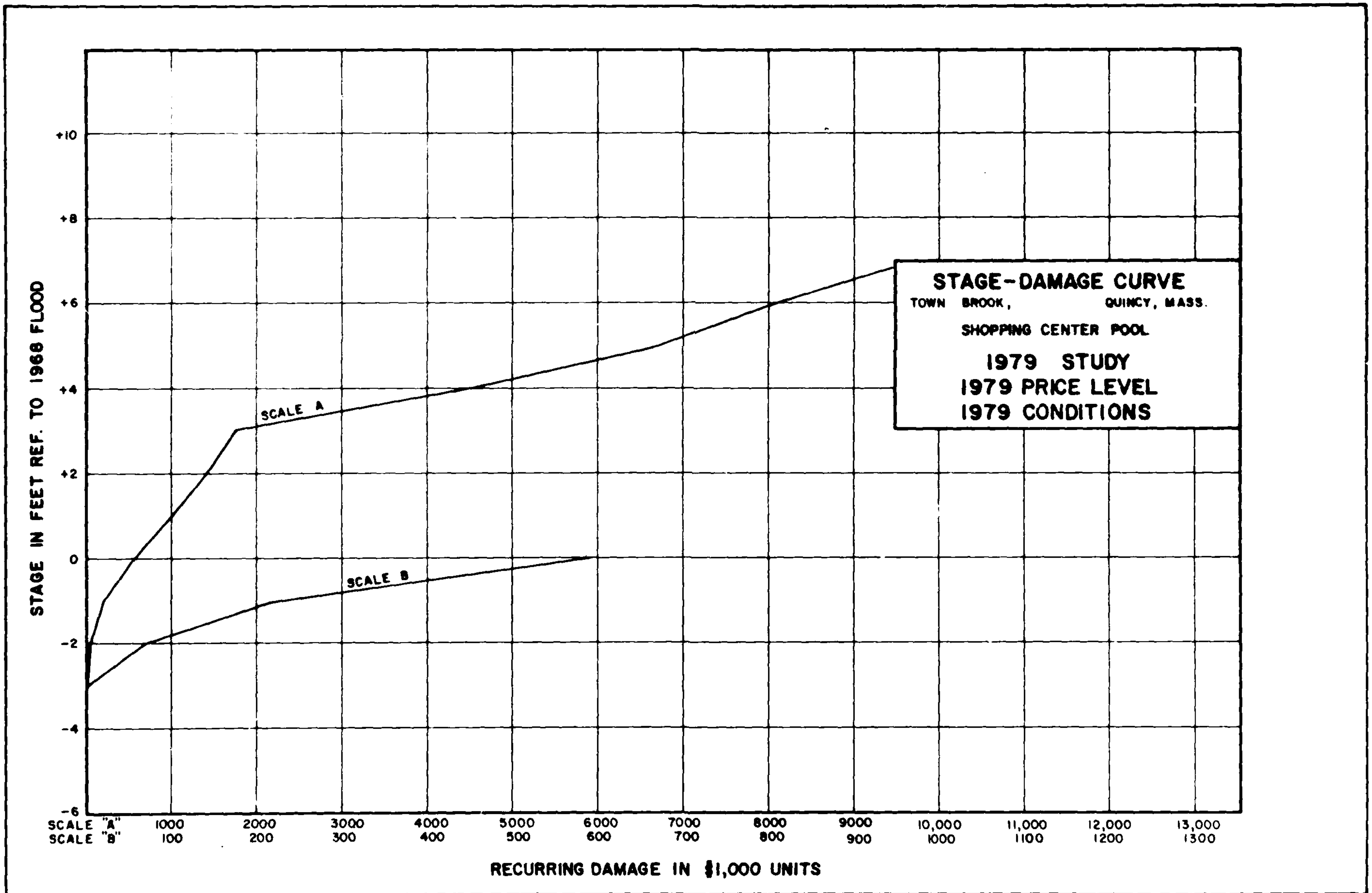
BROOK ROAD POOL

1979 STUDY

1979 PRICE LEVEL

1979 CONDITIONS

PLATE I-2



STAGE-DAMAGE CURVE
TOWN BROOK, QUINCY, MASS.
SHOPPING CENTER POOL
1979 STUDY
1979 PRICE LEVEL
1979 CONDITIONS
SCALE A
SCALE B
STAGE IN FEET REF. TO 1968 FLOOD
+10
+8
+6
+4
+2
0
-2
-4
-6
SCALE "A"
SCALE "B"
1000 100
2000 200
3000 300
4000 400
5000 500
6000 600
7000 700
8000 800
9000 900
10,000 1000
11,000 1100
12,000 1200
13,000 1300
RECURRING DAMAGE IN $1,000 UNITS

	RANGE "A" 1 SQ. IN. = $ 6000			RANGE "B" 1 SQ. IN. = $ 10,000			RANGE "C" 1 SQ. IN. = $ 100,000			ANNUAL AVERAGE	
	AREA	LOSS	BEN.	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSS	BENEFIT
NATURAL	13.4	80400	—	9.62	96,200	—	1.02	102,000	—	278,600	—
NO TUNNEL	17.0	102,000	-21,800	32.17	321,700	-225,500	11.30	1,130,000	-1,028,000	1,553,700	-1275,100
8' TUNNEL	15.8	94000	8000	16.17	159,400	+162,300	0.49	49,000	+1,081,000	302,400	1,251,300
12' TUNNEL	5.7	34200	67800	1.44	14,400	+307,300	0.031	3,100	+1,126,[illegible]	51,700	1,502,000

DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS.

SHOPPING CENTER POOL

1979 PRICE LEVEL

1979 CONDITIONS

1979 STUDY

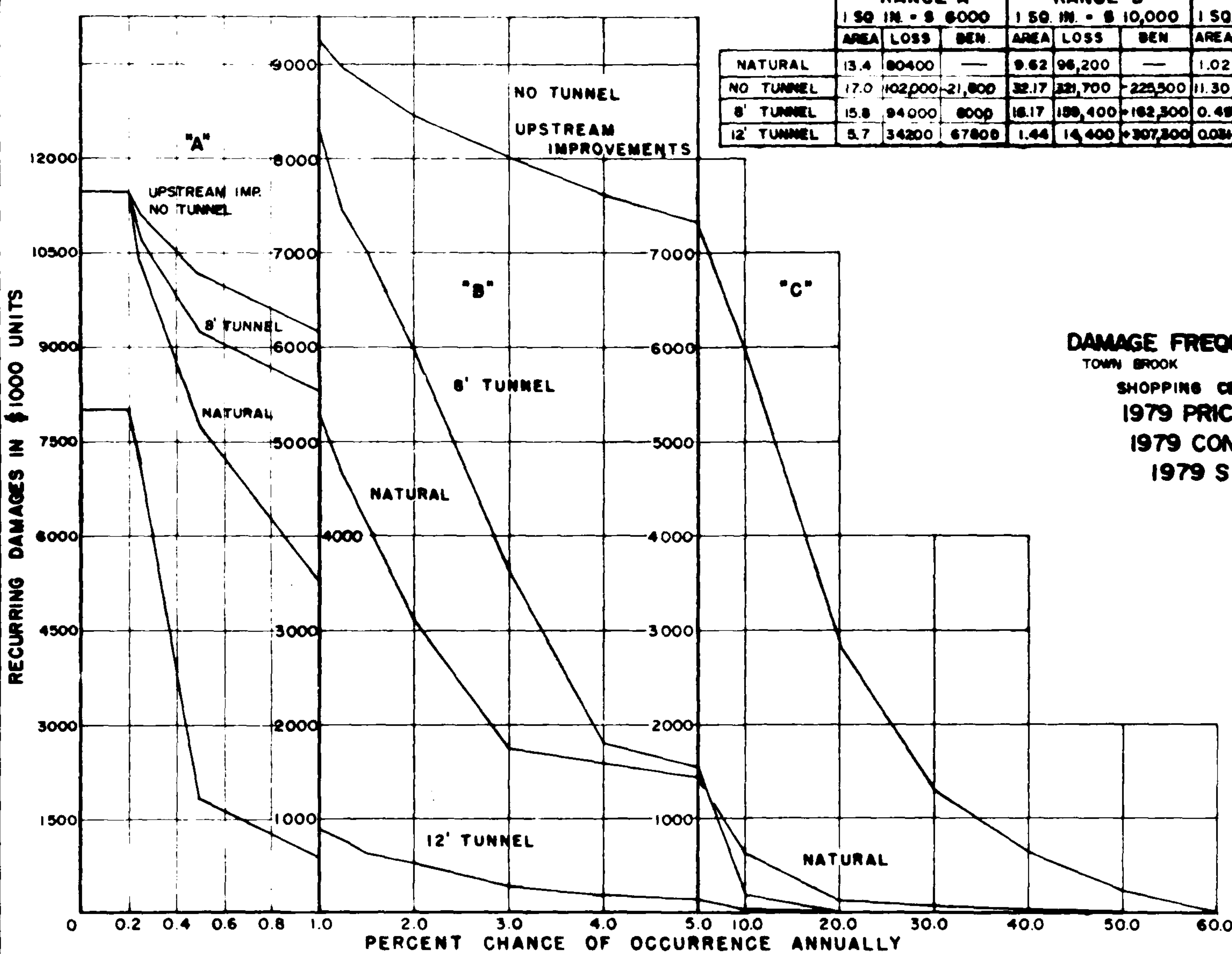
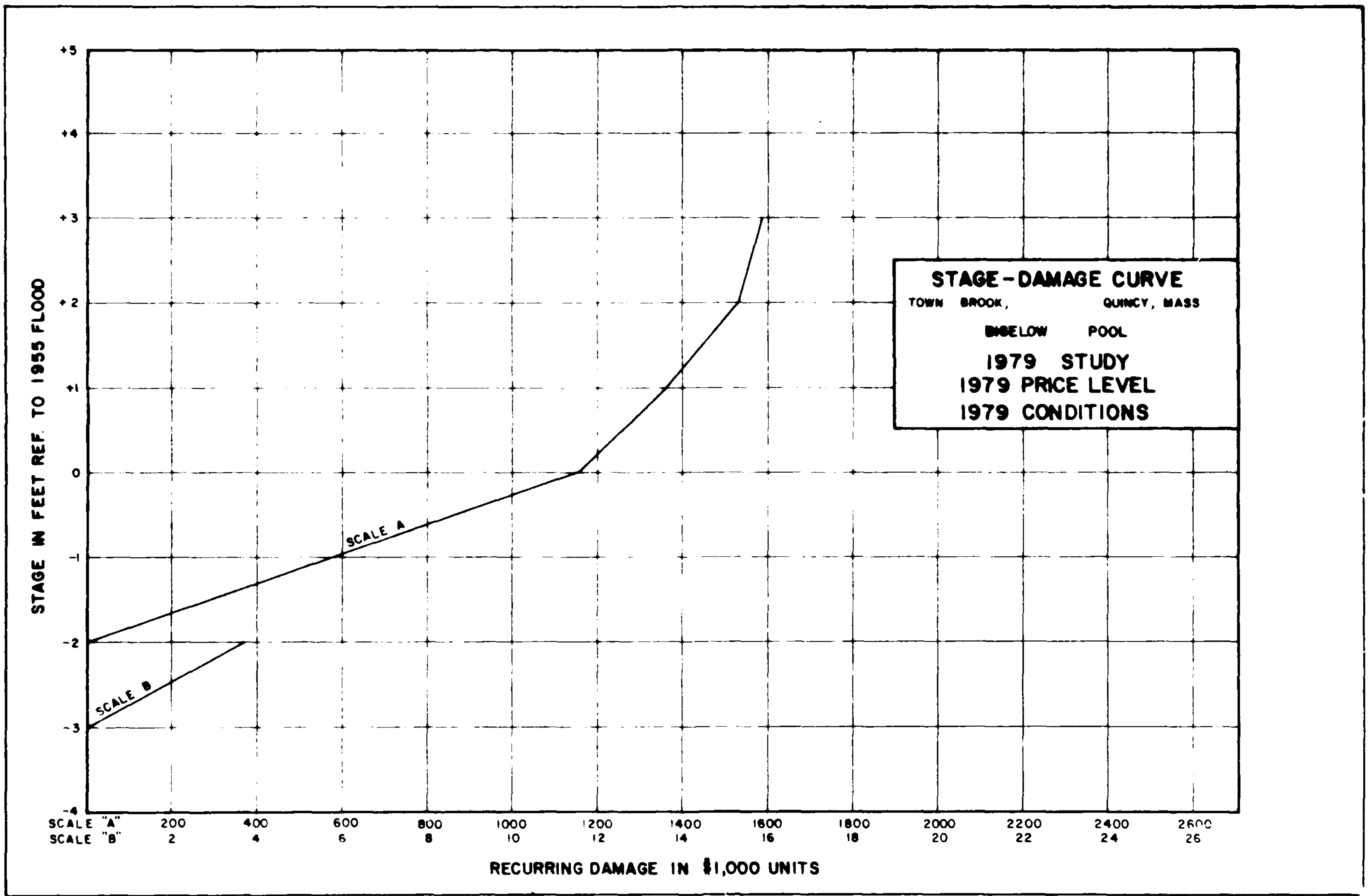


PLATE I-4



STAGE-DAMAGE CURVE
TOWN BROOK, QUINCY, MASS
BIGELOW POOL
1979 STUDY
1979 PRICE LEVEL
1979 CONDITIONS
STAGE IN FEET REF. TO 1955 FLOOD
+5
+4
+3
+2
+1
0
-1
-2
-3
-4
SCALE "A" 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600
SCALE "B" 2 4 6 8 10 12 14 16 18 20 22 24 26
SCALE A
SCALE B
RECURRING DAMAGE IN $1,000 UNITS

PLATE I-

DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS.

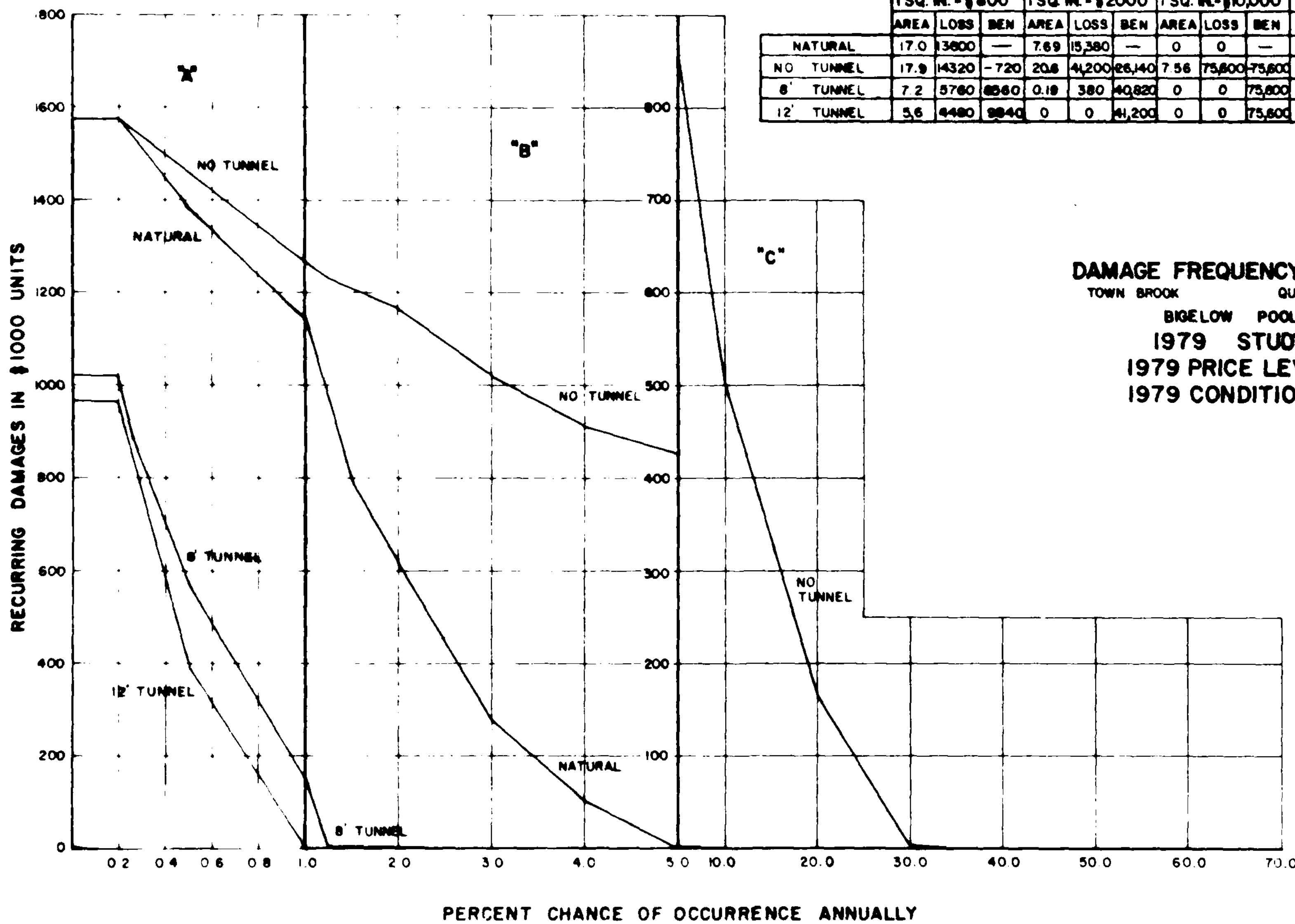
BIGELOW POOL

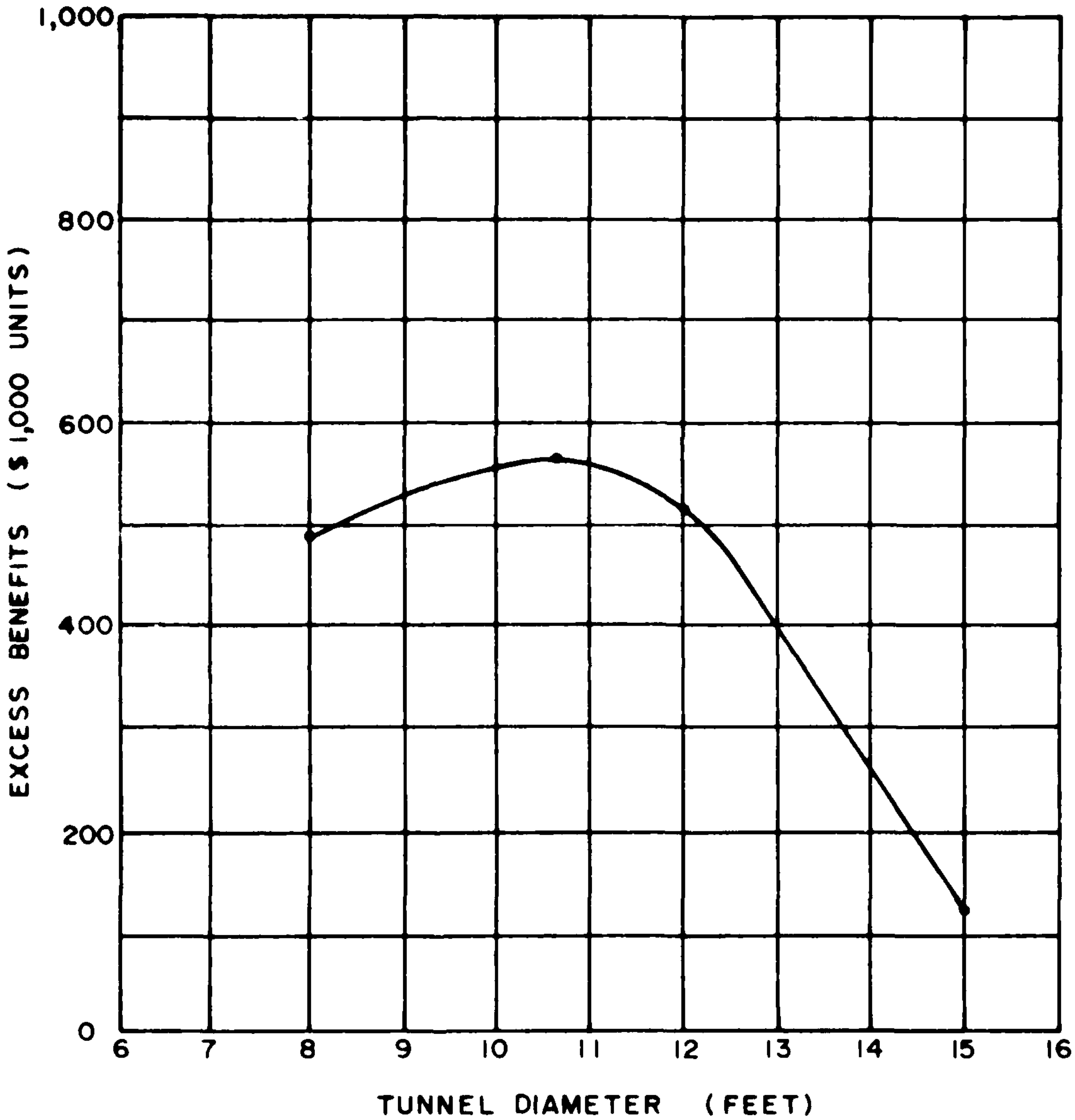
1979 STUDY

1979 PRICE LEVEL

1979 CONDITIONS

	RANGE "A" 1 SQ. IN. = $800			RANGE "B" 1 SQ. IN. = $2000			RANGE "C" 1 SQ. IN. = $10,000			TOTAL ANNUAL	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSSES	BENEFITS
NATURAL	17.0	13600	—	7.69	15,380	—	0	0	—	28980	—
NO TUNNEL	17.9	14320	-720	20.6	41,200	-26,140	7.56	75,600	-75,600	131,120	-102,460
8' TUNNEL	7.2	5760	8560	0.19	380	40,820	0	0	75,600	6,140	124,980
12' TUNNEL	5.6	4480	9840	0	0	41,200	0	0	75,600	4480	126,640





TOWN BROOK
QUINCY LOCAL PROTECTION
EXCESS BENEFITS CURVE

PLATE I-7

	RANGE "A" 1 SQ. IN. = $800			RANGE "B" 1 SQ. IN. = $2000			RANGE "C" 1 SQ. IN. = $20,000			TOTAL ANNUAL	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSSES	BENEFITS
NATURAL	14.0	11200	—	7.4	14800	—	2.4	48000	—	74,000	——
NO TUNNEL	16.0	12800	-1600	12.4	24800	-10000	3.6	72000	-24000	109,600	-35600
8' TUNNEL	14.0	11200	1600	7.4	14800	10000	2.4	48000	24000	74,000	35600
12' TUNNEL	8.0	6400	6400	2.1	4200	20600	.4	8000	64000	18,600	91,000

DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS

BROOK ROAD POOL

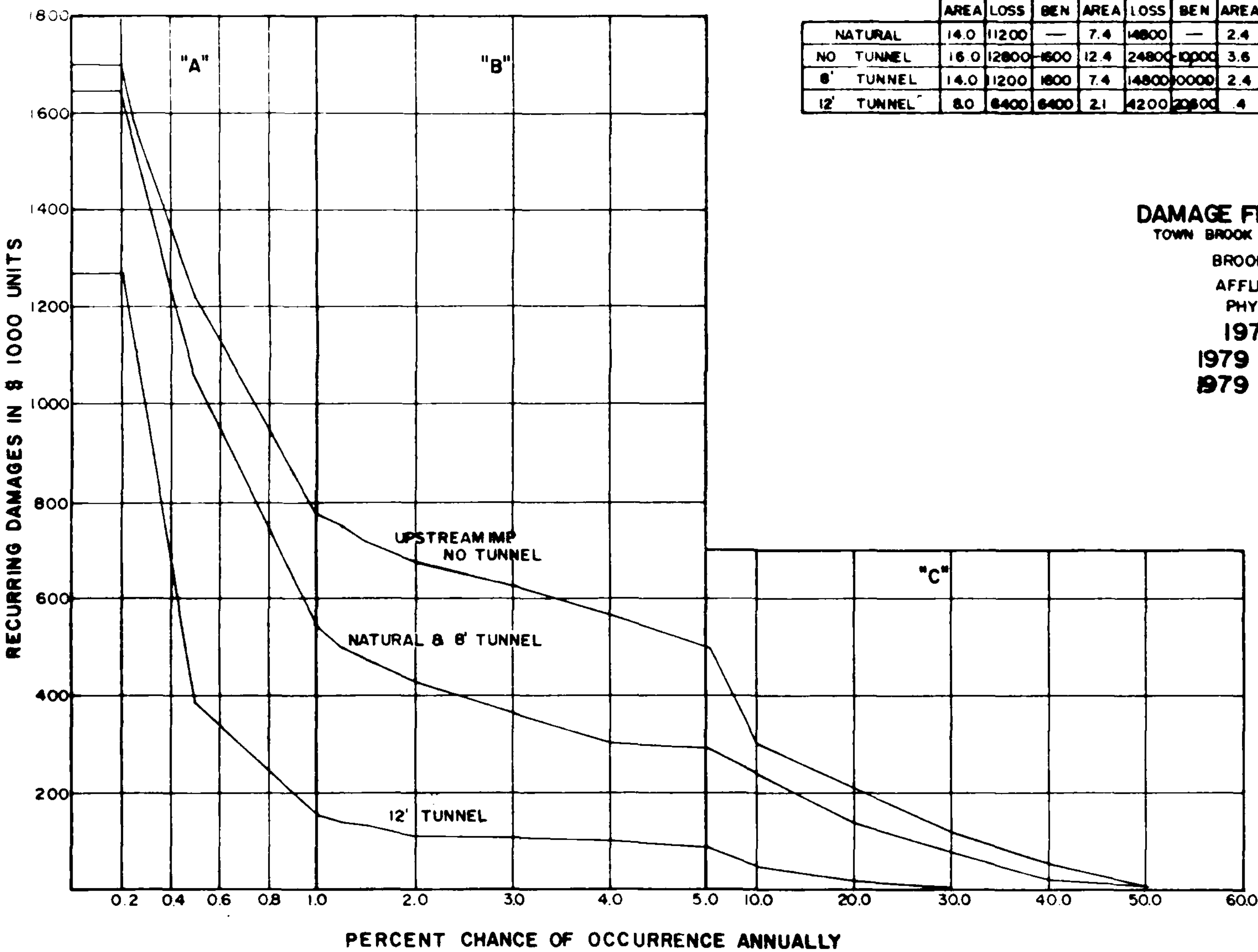
AFFLUENCE BENEFITS

PHYSICAL LOSSES

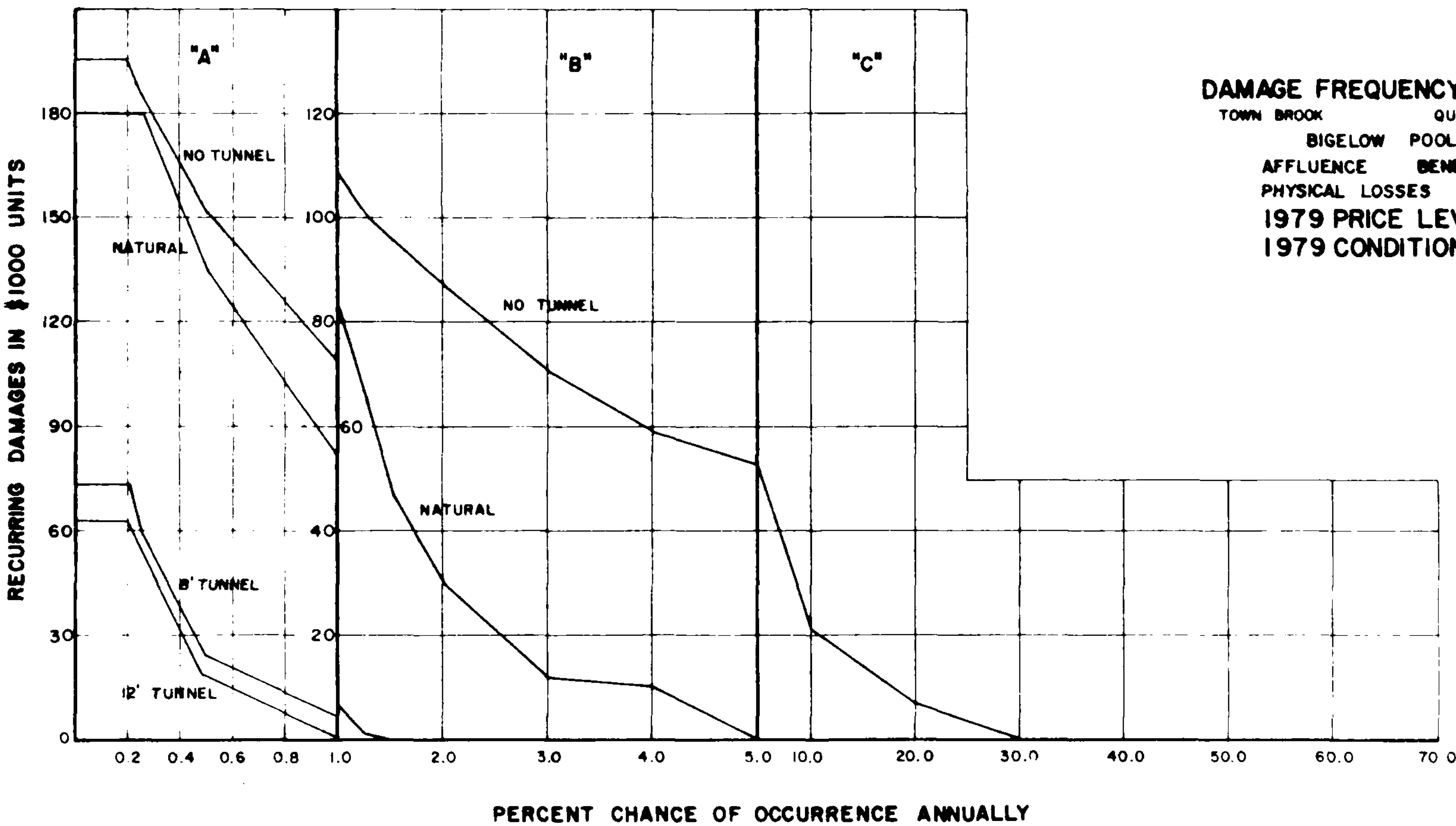
1979 STUDY

1979 PRICE LEVEL

1979 CONDITIONS



	RANGE "A" 1 SQ. IN. = $120			RANGE "B" 1 SQ. IN. = $200			RANGE "C" 1 SQ. IN. = $2000			TOTAL ANNUAL	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSSES	BENEFITS
NATURAL	11.5	1380	—	4.5	900	—	0	0	—	2,280	—
NO TUNNEL	14.2	1,704	-324	14.9	2,980	-2,080	1.9	3,800	-3,800	8484	-6204
8' TUNNEL	3.0	360	1344	0.1	20	2,980	0	0	3,800	380	8104
12' TUNNEL	2.4	288	1416	0	0	2,980	0	0	3,800	288	8196



DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS.

BIGELOW POOL

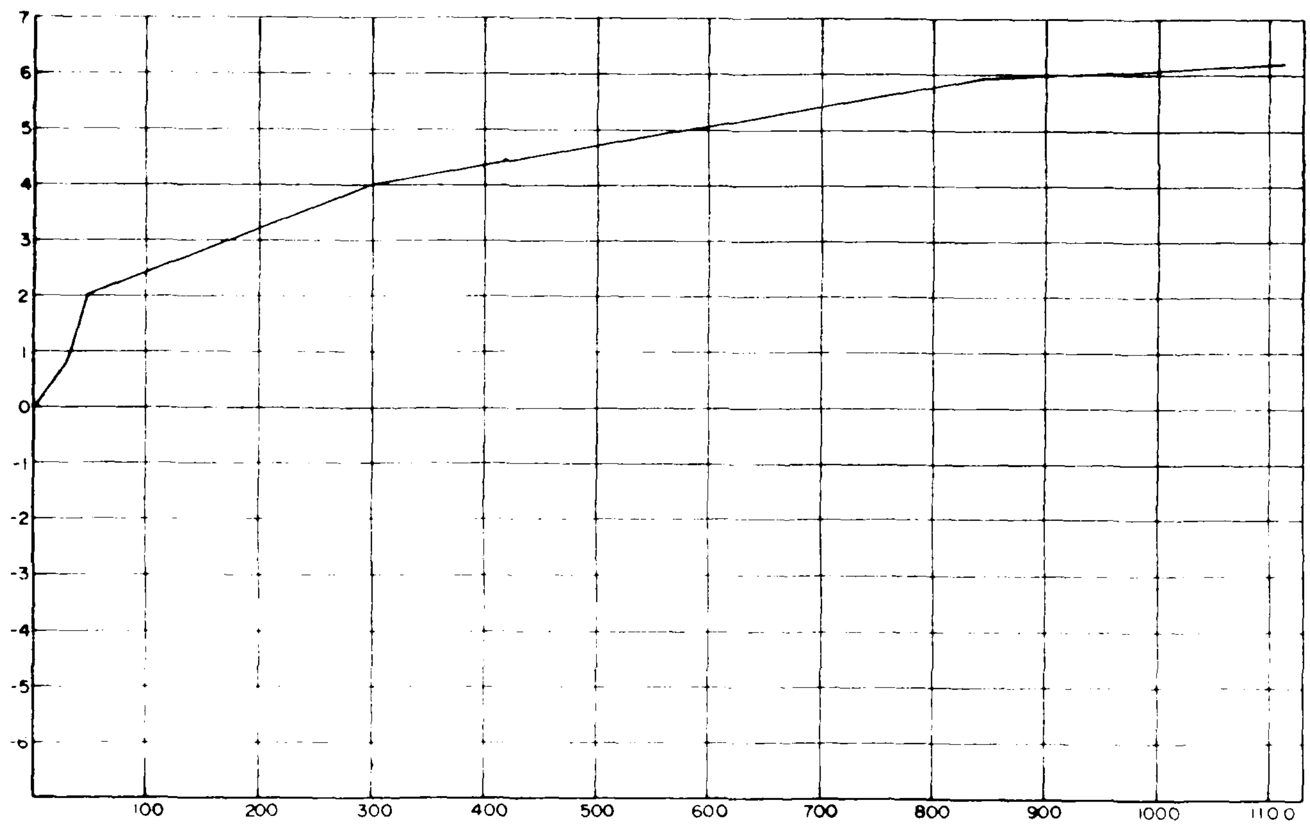
AFFLUENCE BENEFITS

PHYSICAL LOSSES ONLY

1979 PRICE LEVEL

1979 CONDITIONS

PLATE I-9



STAGE DAMAGE CURVE

TOWN BROOK QUINCY, MASS

BROOK ROAD POOL

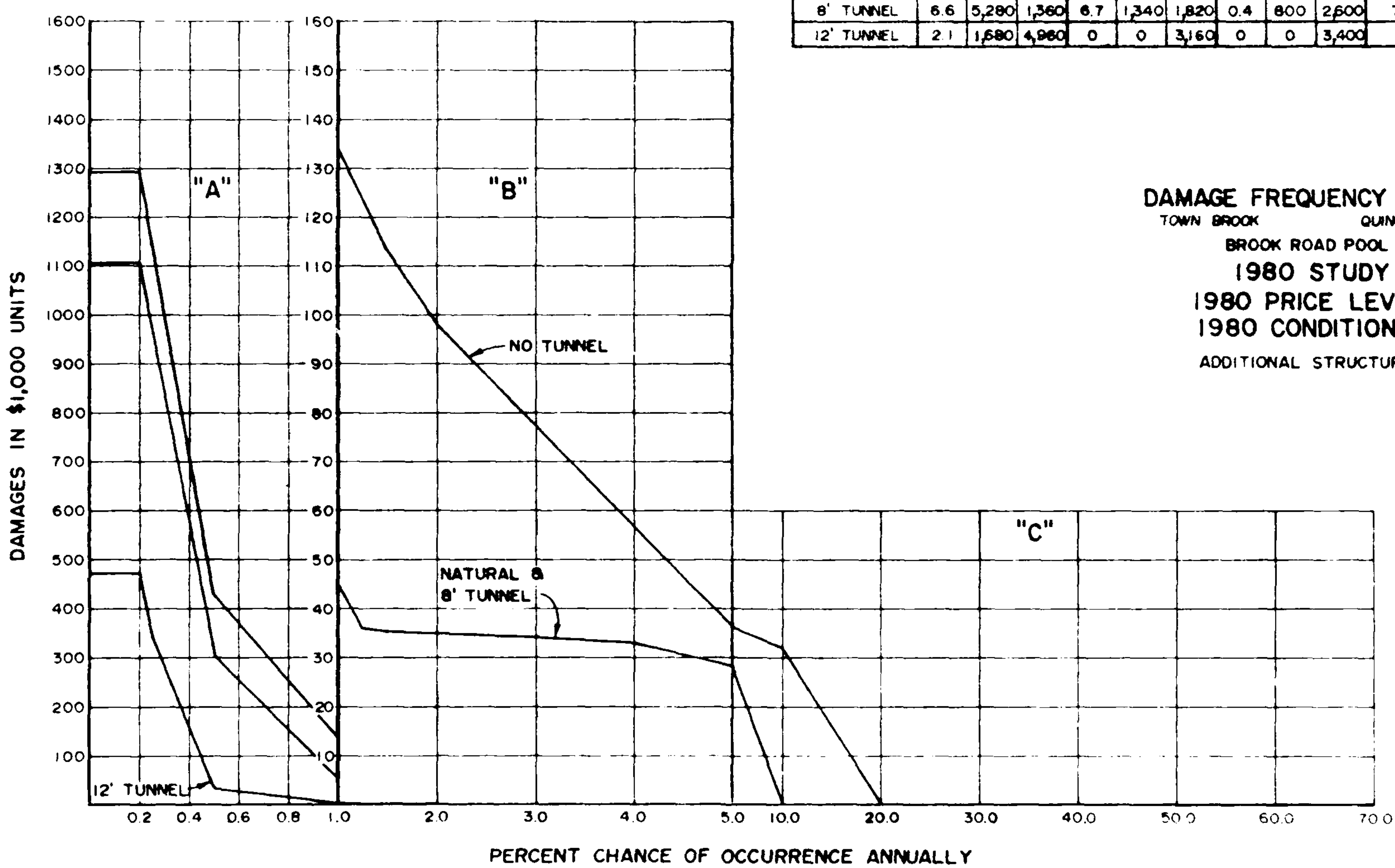
1980 STUDY

1980 PRICE LEVEL

1980 CONDITIONS

ADDITIONAL STRUCTURES

	RANGE "A" 1 SQ. IN. = $800			RANGE "B" 1 SQ. IN. = $200			RANGE "C" 1 SQ. IN. = $2,000			ANNUAL AVERAGE	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSSES	BENEFIT
NATURAL	6.6	5,280	–	6.7	1,340	–	0.4	800	-	7,420	—
NO TUNNEL	8.3	6,640	-1,360	15.8	3,160	-1,820	1.7	3,400	-2,600	13,200	-5,780
8' TUNNEL	6.6	5,280	1,360	6.7	1,340	1,820	0.4	800	2,600	7,420	5,780
12' TUNNEL	2.1	1,680	4,960	0	0	3,160	0	0	3,400	1,680	11,520



DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS.

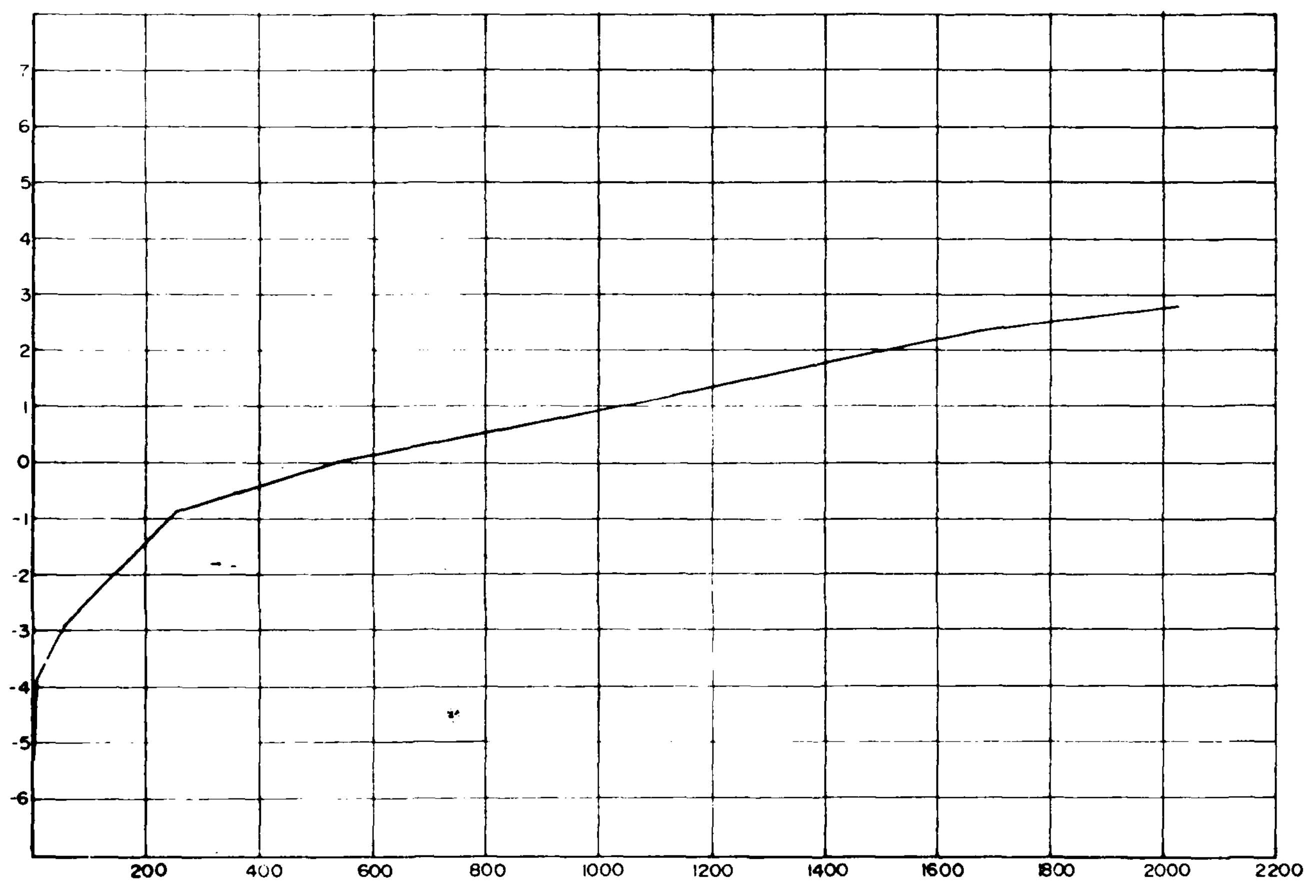
BROOK ROAD POOL

1980 STUDY

1980 PRICE LEVEL

1980 CONDITIONS

ADDITIONAL STRUCTURES



STAGE DAMAGE CURVE

TOWN BROOK QUINCY, MASS

BIGELOW STREET POOL

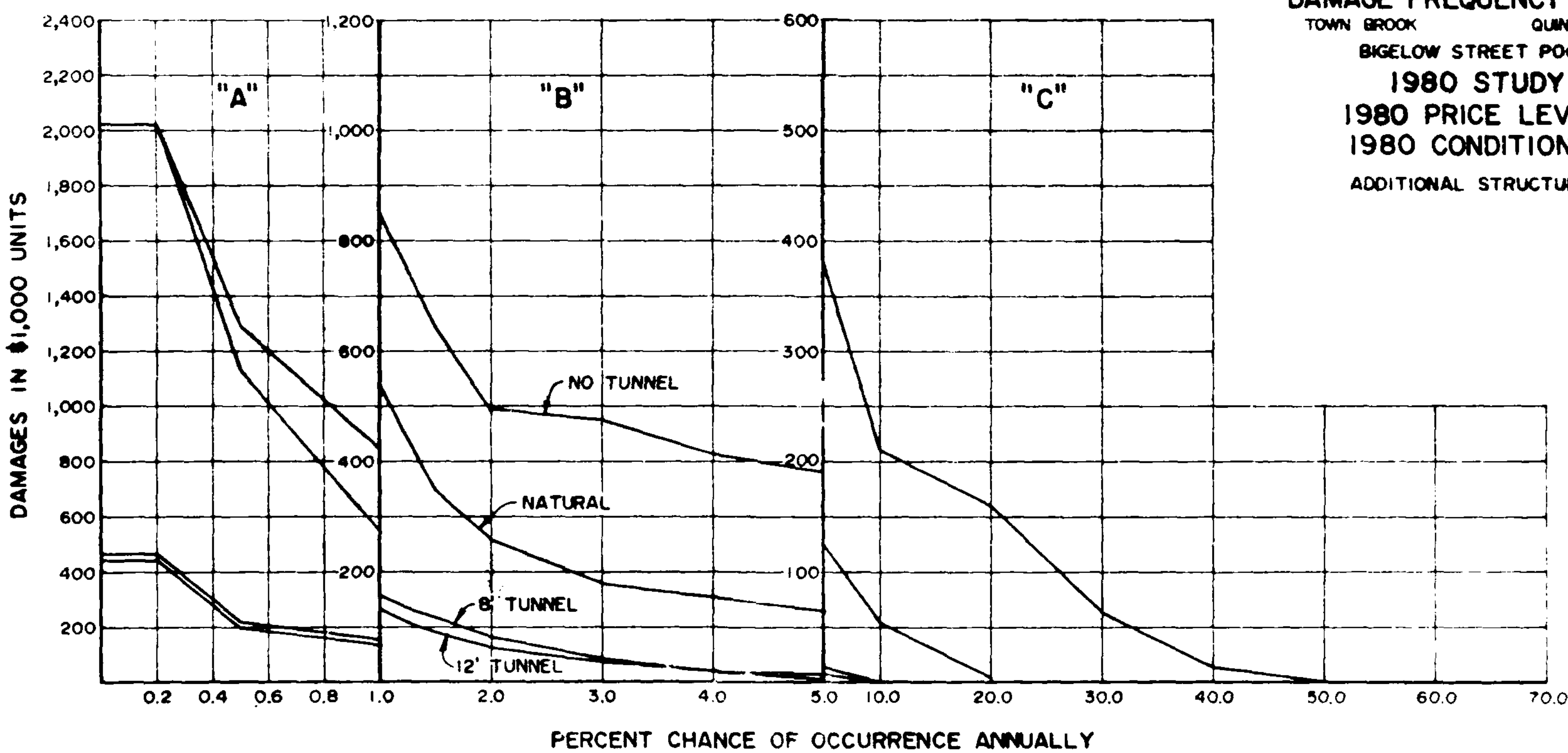
1980 STUDY

1980 PRICE LEVEL

1980 CONDITIONS

ADDITIONAL STRUCTURES

	RANGE "A" 1 SQ. IN. = $1,600			RANGE "B" 1 SQ. IN. = $2,000			RANGE "C" 1 SQ. IN. = $10,000			ANNUAL AVERAGE	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSSES	BENEFIT
NATURAL	8.1	12,960	-	4.4	8,800	-	0.8	8,000	-	29,760	—
NO TUNNEL	9.0	14,400	-1,440	9.9	19,800	-11,000	4.9	49,000	-41,000	83,200	-53,440
8' TUNNEL	1.8	2,880	11,520	1.2	2,400	17,400	0.05	500	48,500	5,780	77,420
12' TUNNEL	1.7	2,720	11,680	0.9	1,800	18,000	0.02	200	48,800	4,720	78,480



DAMAGE FREQUENCY CURVE

TOWN BROOK QUINCY, MASS.

BIGELOW STREET POOL

1980 STUDY
1980 PRICE LEVEL
1980 CONDITIONS

ADDITIONAL STRUCTURES

Appendix J

Real Estate Studies

APPENDIX J

REAL ESTATE STUDIES

TABLE OF CONTENTS

	Page No.
INTRODUCTION	J-1
Purpose	J-1
Location and Area Data	J-1
DESCRIPTION OF PROJECT	J-1
Old Quincy Reservoir Area	J-1
Tunnel Plan	J-1
RIGHTS TO BE ACQUIRED	J-2
Permanent Subsurface Easements	J-2
Ownerships Affected - Subsurface Tunnel	J-3
Temporary Easements	J-3
APPROACH TO VALUE	J-3
ACQUISITION COSTS	J-4
Relocation Assistance Costs	J-4
Protection and Enhancement of Cultural Environment	J-4
Government-Owned Facilities	J-4
Tax Loss	J-4
Severance Damages	J-4
Contingencies	J-5
Water Rights	J-5
Real Estate Costs	J-5

INTRODUCTION

Purpose

The purpose of this report is to estimate the fair market value of real estate interests and the allied real estate costs for the proposed modifications to the local flood protection plan for Town Brook, Quincy, Massachusetts.

Location and Area Data

Quincy is bordered on the north by Boston and on the north and east by the Atlantic Ocean. It is located on Boston Harbor and Quincy Bay. The area was originally settled in 1625 and was incorporated as a town in 1792. The town was mainly an agricultural community until 1830, when the expansion of the shoe trade brought about an outgrowth of tanneries on the Town Brook. Technological improvements in the quarrying of granite brought about an expansion of this industry and soon Quincy granite was known all over the world. Today, Quincy is primarily a manufacturing city and has a population of about 90,000.

DESCRIPTION OF PROJECT

Old Quincy Reservoir Area

That real estate portion of the Town Brook flood control study involves the construction of a dike between Lakeside Drive and the Quincy Reservoir in Braintree with a modification of the reservoir's present dam outlet structure and construction of an enlarged emergency spillway. The dike, modification of the dam outlet structure and spillway enlargement would be on lands currently owned by the city of Quincy. Town Brook would remain in its present course from Old Quincy Reservoir and will flow through downtown Quincy and the lower reaches of the brook. One public ownership would be affected by this segment of the project.

Tunnel Plan

A 12-foot diameter tunnel would be located in bedrock about 100 feet below the surface. There are three alternative tunnel alignment plans. The inlet structure of the relief tunnel would be located just off School Street in Quincy, adjacent to the "Red Line" of the Massachusetts Bay Transportation Authority (MBTA). The inlet structure, as planned, would be about 40 feet x 50 feet in size and designed to receive flows from Town Brook and from proposed relief drainage conduits in the vicinity. One private and one public ownership would be affected by construction of the inlet structure. All three alternative alignments for the tunnel would be constructed beneath city streets and several private ownerships. Where the tunnel passes under private ownerships, permanent easement interests would be acquired. The selected tunnel alignment would extend from the inlet in a northeasterly direction and terminate at one of the three outlet locations. Description of each alignment and discharge location follows:

Alternative Tunnel Plan 1 -Under this plan the tunnel would pass beneath 35 private ownerships, terminating at an outlet structure on city-owned lands about 1,700 feet from Town River Bay. From the outlet structure the surface flow would enter Town River. The proposed plan would require larger culverts beneath the supermarket parking lot and the Southern Artery. The north bank of the existing Town River channel, downstream of the Southern Artery, would have to be excavated to a minimum 40-foot width for a distance of about 500 feet. Purchase of the privately owned marshland in the outlet area is planned to prohibit any future development of this water storage area.

Two options were considered for dealing with the supermarket. The first was to take a construction easement and make provisions to minimize the impact on business during construction. This appeared to be the most desirable. The second approach was to make the assumption that the construction would cause significant impact on the store's business and the property should be purchased and the business relocated.

Alternative Tunnel Plan 2 - Alternative Tunnel Plan 2 is almost identical to Plan 1 except the tunnel alignment would vary slightly and the outlet would surface 800 feet farther upstream of Town Brook Bay.

The acquisition and construction for this plan would be the same as Plan 1 except for the additional 800 feet of channel improvement. The tunnel would pass beneath 31 private ownerships where permanent subsurface easements would be required.

Alternative Tunnel Plan 3 - Alternative Tunnel Plan 3 has a different tunnel alignment that would locate the outlet on city of Quincy's property adjacent to Town River Bay. This plan would not require any of the acquisition and construction proposed in Plans 1 and 2 for Town River, which serves as the outlet channel for those plans. It is estimated that the tunnel would pass beneath 26 private ownerships where permanent sursurface easements would be required.

RIGHTS TO BE ACQUIRED

Local interests are required to provide all lands, easements and rights-of-way necessary for project construction.

Permanent Subsurface Easements

Permanent sursurface easements acquired would affect a total of approximately 26 to 35 private ownerships, depending on which tunnel plan is selected. A nominal value in the amount of $100 per ownership is estimated to be a fair and reasonable cost for the easement interest. Preliminary investigations indicate that after the imposition of the easement interest, the highest and best use of all the properties affected by this proposed acquisition program will not be materially affected. However, it is historically known that

the mere knowledge and existence of the imposition infers a restrictive aspect. The costs for the easement rights are predicated on the assumption that construction methods will not be of the blasting magnitude that would adversely affect surface or near-surface inground improvements. If it is determined and found that selected methods of construction would cause damage to surface or near-surface inground improvements, then the estimated nominal value for the easement right would not remain valid and a new indepth real estate study of the proposed taking area would be required.

Ownerships Affected - Subsurface Tunnel

The estimated ownerships affected are:

Plan 1 35 Private plus City of Quincy

Plan 2 31 Private plus City of Quincy

Plan 3 26 Private plus City of Quincy

Temporary Easements

Temporary construction easements will be necessary at the inlet location and at the outlet area unless it is located on city property.

The cost for temporary construction easements is estimated to be about 15 percent of the estimated market value of the land per year. This amount is predicated on an amount equal to the estimated fair return an investor might expect on invested capital. For purposes of this report, it is estimated that the construction easements will be required for 2 years.

APPROACH TO VALUE

The estimated fair market value of the real estate required for project purposes is based upon a study of comparable sales in the vicinity, discussions with people knowledgeable in the local real etate market, the appraiser's general knowledge of values in the area, and experience of this office in similar projects.

Zoning - The lands affected by the project are zoned commercial, industrial and residential.

Highest and Best Use - The highest and best use of the affected private lands is considered to be the present use.

Evaluation - The value of the lands and improvements within the project area have been estimated by use of the market data or sales comparison approach. This approach to value involves a comparison between the subject properties and recent sales transactions of properties that compare favorably and are located in the vicinity of the project area.

A search was conducted in the general area to obtain market data. Local officials, real estate brokers and appraisers, and other knowledgeable persons were interviewed to obtain data and value estimates.

In conclusion, consideration was given to all items which might have an influence on the final estimate of real estate costs.

ACQUISITION COSTS

Acquisition costs will include mapping and surveys, legal description, title evidence, appraisals, negotiations, and closing and administrative costs for possible condemnations. The acquisition costs are based upon this office's experience in similar civil works projects in this general area and are estimated at $3,000 per ownership.

Relocation Assistance Costs

Public Law 91-646, Uniform Relocations Assistance Act of 1970, provides for equitable treatment of persons displaced from their homes, businesses, or farms by a Federally assisted program. In accordance with this law, a sum of $200 per ownership for those owners above the tunnel channel is estimated to cover possible reimbursable expenses incidental to the transfer of real estate interests that may be incurred by the private ownerships in this acquisition program. In the absence of a detailed study of the supermarket business, for the relocation option a cost of $50,000 is assigned for planning purposes.

Protection and Enhancement of Cultural Environment

There are no known structures of historic significance that would be affected by the proposed modifications.

Government-Owned Facilities

Section III of the Act of Congress, (PL 85-500), approved 3 July 1958, authorized the protection, realteration, reconstruction, relocation or replacement of municipally owned facilities. There are no Government-owned facilities in the project area that would be adversely affected by the project.

Tax Loss

Under Alternative Plans 1 and 2 - If the supermarket property were to be acquired, the city of Quincy would incur a tax loss for a one year period in the estimated amount of $60,000. It is assumed that the supermarket property would revert to the private sector after completion of construction.

Severance Damages

Severance damages usually occur when partial takings are acquired, which restricts the remaining portion from full economic development. The severance damages are measured and estimated on the basis of "before" and "after" appraisal methods and reflect actual value loss incurred to the

remainder as a result of partial acquisition. This preliminary investigation indicates there will be no severance damages to the properties involved in the project.

Contingencies

A contingency allowance of 20 percent is considered to be reasonably adequate for possible appreciation of property values from the time of this estimate to acquisition date, for possible minor property line adjustment or for additional hidden ownerships which may be developed by refinement of taking lines, for adverse condemnation awards and to allow for practical and realistic negotiations.

Water Rights

The lands that would be acquired by permanent easement will not affect any riparian interests which the grantors may have in their properties and they will continue to enjoy access to the water and any other uses that will not interfere with the terms of the easements.

Real Estate Costs

The following is a summary of the estimated real estate costs based upon a preliminary plan furnished this office on 12 March 1980, entitled "Quincy Coastal Studies - Town Brook, Quincy, Massachusetts."

Plan 1 (No relocations)

Land, 3.55 Acres in Fee	$23,000	
Permanent Easement 35 Private Ownerships	28,500	
Temporary Easement Inlet 0.33 Acre	500	
Contingency (20% of $52,000)	10,400	
		$ 62,400
Relocation Assistance Costs 35 Private Ownerships		7,000
Acquisition Costs 35 Private Ownerships		105,000
Total Estimated Real Estate Costs		$174,400
	Call	$175,000

Plan 1 (With relocation)

Land, 5.64 Acres in Fee	$273,000	
Improvements	750,000	
Permanent Easement 35 Private Ownerships	3,500	
Temporary Easement Inlet 0.33 Acre	500	
Severance Damage	0	
Contingency (20% of 1,027,000)	205,400	
		$1,232,400
Relocation Assistance Costs 35 Private Ownerships 1 Supermarket		 7,000 50,000
Acquisition Costs 35 Private Ownerships		105,000
Total Estimated Real Estate Costs		$1,394,400
	Call	$1,400,000

Plan 2

Land, 5.64 Acres in Fee	$273,000	
Improvements	750,000	
Permanent Easement 31 Private Ownerships	3,100	
Temporary Easement Inlet 0.33 Acre	500	
Severance Damage	0	
Contingency (20% of 1,026,600)	205,320	
		$1,231,920
Relocation Assistance Costs 31 Private Ownerships 1 Supermarket		6,200 50,000
Acquisition Costs 31 Private Ownerships		93,000
Total Estimated Real Estate Costs		$1,381,120
	Call	$1,380,000

Plan 3

Land Inlet 0.41 Acre in Fee Outlet - City Property	$18,000 0	
Permanent Easement 26 Ownerships	2,600	
Temporary Easement Inlet 0.33 Acre	500	
Severance Damage	0	
Contingency (20% of 21,100)	4,220	
		$25,320
Relocation Assistance Costs 26 Ownerships		5,200
Acquisition Costs 26 Ownerships		78,000
Total Estimated Real Estate Costs		$108,520
	Call	$109,000